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RESEARCH REPORT 65

CREDIT FOR ALLEVIATION OF RURAL POVERTY: THE GRAMEEN BANK IN BANGLADESH

Mahabub Hossain

February 1988

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FOREWORD

There is a growing recognition that institutional credit plays an important role in the modernization of agriculture through technological change. It is clear that as those processes of modernization occur, incomes rise and expenditures on locally produced goods and services expand in such a manner as to increase the demand for labor and labor-intensive entrepreneurial activities. The question then arises as to what extent institutional credit can be offered to very poor people to facilitate their taking direct advantage of the developing entrepreneurial activities.

Perhaps the most widely admired effort to answer this question is that of the Grameen Bank in Bangladesh. One of the commendable features of the Grameen Bank is its desire to have its experience intensely analyzed for the benefit of others who are considering such an effort, as well as for its own improvement.

Mahabub Hossain conducted this in-depth analysis as a staff member of the Bangladesh Institute of Development Studies, which undertook a comprehensive research project on evaluation of the Grameen Bank. The International Food Policy Research Institute, in connection with a range of collaborations with Mahabub Hossain and BIDS, is pleased to have provided support to him in the writing phase of this study of the Grameen Bank.

Particularly notable in the findings is the importance of the institutional philosophy that has been so ably implemented by the founder of the bank, Dr. Muhammad Yunus, through a complex management structure. Clearly, however, the scale of the bank's operations is now far beyond the pilot stage, so the lessons are real and important.

Related to the bank's philosophy is a set of costs that seem necessary to success. These costs are high and, although not unacceptable, suggest the possible need for some subsidization. The costs come to 26.5 percent of the loans and advances, using market rates for borrowed funds—that is about 10 percentage points higher than the substantial 16 percent rate charged. In noting this, emphasis must be given not only to the equity implications but to the development implications of bringing large numbers of low-income people into the discipline of economic development derived from a credit system that has virtually no overdues or bad loans. Indeed, in comparing the substantial costs of Grameen Bank lending, it is especially notable that rural credit systems in developing countries typically have overdues on the order of half the level of new loans. The Grameen Bank has an approach that keeps overdues and loan losses at close to zero.

These and a vast number of other economic issues are tackled in Mahabub Hossain's research report. In addition, BIDS is bringing out a number of reports on the impact of the bank relating to social and administrative issues. The findings in this study are important in that they are broad and detailed and will contribute to needed policy improvements in the rural credit programs of developing countries.

Rehman Sobhan
Director General, Bangladesh Institute
of Development Studies

John W. Mellor
Director, IFPRI

February 1988

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1

SUMMARY

The Grameen Bank is a specialized financial institution in Bangladesh that was established by government order in 1983 to provide credit to the rural poor for the purpose of improving their economic condition. The bank originated in 1976 as an action-research project in an area near Chittagong University to test the hypothesis that if the poor are supplied with working capital they can generate productive self-employment without external assistance. The bank now has a paid-up capital of Tk 72 million. Seventy-five percent of the shares are owned by the bank's borrower shareholders and 25 percent by the government. One member of a household that owns less than 0.5 acre of cultivable land or assets not exceeding the value of 1.0 acre of land is eligible to take loans from the bank. A loan is issued without any collateral and bears an interest rate of 16 percent a year.

The bank has progressed at a fast pace. By February 1987 it had opened 298 branches and mobilized nearly 250,000 households from 6 percent of the villages in the country. In the same period, it covered more than 25 percent of its target-group households in Tangail and Patuakhali districts, and 8-12 percent of the target group in the other three districts under its operation. At the end of 1986, the amount of outstanding loans stood at Tk 301 million. The yearly disbursement of loans increased from Tk 99 million in 1983 to Tk 542 million in 1986. The expansion of coverage of women, one of the most disadvantaged groups in rural society, has been impressive. At the end of 1986, women accounted for 74 percent of all members and 69 percent of outstanding loans. Nearly 98 percent of the new members mobilized during 1986 were women.

Loans from the Grameen Bank are used primarily for undertaking noncrop activities. In 1986, 46 percent of the loans were taken for livestock and poultry raising, 25 percent for processing and manufacturing activities, and 23 percent for trading and shopkeeping. The major activities financed are milch cow raising, paddy husking, cattle fattening, seasonal crop trading, paddy and rice trading, cattle and goat trading, handloom weaving, cloth trading, and grocery shop operating. With the increase in the proportion of women borrowers, who take loans mostly for livestock raising and paddy husking, the amount disbursed for livestock raising has increased.

Since 1982, credit has been issued to groups consisting of a number of borrowers for collective enterprises such as investing in irrigation machines, rice hullers, oil mills, and power looms; leasing markets; and leasing land for cooperative farming. The intent of these collective enterprise loans is to take advantage of improved technology and economies of scale, but they have had limited success, primarily because of difficulty in managing large groups and unfamiliarity with the enterprises. The share of the collective enterprise loans increased briskly from 1.9 percent in 1983 to 8.2 percent in 1984, but fell sharply during 1985 and 1986.

The bank has succeeded in reaching its target group. Only 4.2 percent of the members belong to households that own 0.5 acre or more of cultivable land. The target-group households that are left out are more numerous among agricultural wage laborers than among other occupational groups. About 60 percent of the Grameen Bank target group are agricultural-labor households, but agricultural labor was found to be the principal or subsidiary occupation for only 20 percent of members before they joined the bank.

The loan repayment performance is excellent. Only 0.5 percent of loans to 975 borrowers surveyed were overdue beyond one year, and overdue weekly installments (before the expiration of the one-year repayment period) were only 3.3 percent of the total amount borrowed. Most of the overdue loans were with nontarget-group members and repeat borrowers. Eighty-one percent of women borrowers had no overdue installments at the time of the survey, compared with 74 percent for men. A significant proportion of new borrowers pay installments in advance, presumably to get another and larger loan as early as possible. The main factors behind the excellent recovery of Grameen Bank loans are (1) the ability of the bank to confine credit services to the extremely needy; (2) the strong management system developed by the bank's founder-managing director, including decentralization of power and responsibilities, and intensive training of bank workers; (3) the provision of loans for activities that generate regular incomes; (4) the collection of repayments in small amounts, suitable to the circumstances under which the poor earn and live; and above all, (5) the dedicated services of the bank workers, who are strongly motivated by the dedication of the managing director and regard their work as an opportunity to serve the poor rather than simply to earn an income for themselves.

The Grameen Bank has a pervasive effect on the credit market in the area of its operation. Very few of the bank's target group get credit from formal lending agencies, and only about a fifth of them are served by informal lenders. With Grameen Bank intervention, the proportion of households receiving institutional credit increases to about a third—almost two-thirds among the target group. The share of Grameen Bank credit in total loans taken by all households in five randomly selected villages was 78 percent in 1984/85. Most of the institutional credit outside the bank went to the nontarget-group households.

The most direct effect of the Grameen Bank has been on the accumulation of capital by the poor. The amount of working capital employed by members' enterprises increased by an average of three times within a period of 27 months. The investment in fixed assets is about 2.5 times higher for borrowers with more than three years' membership than for those who joined during the year of the survey. The number of cattle owned per 100 borrowers increased from 61 before joining the bank to 102 at the time of the survey—an increase of 26 percent a year.

Grameen Bank loans help to generate new employment, particularly for poor women. About a third of the members reported that they were unemployed before joining the bank—almost 7 percent of the men and about 50 percent of the women. With the loans, these members generated self-employment in activities of their choice.

An in-depth household survey in five project villages and two control villages found that Grameen Bank members had incomes about 43 percent higher than the target group in the control villages, and about 28 percent higher than the target-group nonparticipants in the project villages. This positive income effect is mainly due to large increases in income from processing and manufacturing, trading, and transport services financed by the bank loans. A comparison of the incomes of different landownership groups in the selected project and control villages shows that the positive income effect has been highest for the absolutely landless, followed by the marginal landowners, but the income of the nontarget group is lower in the project villages than in the control villages, and the difference is largest for the higher-landownership groups. This variation indicates that the increase in income of the poor is partly due to a redistribution of income from the rich. But it appears that Grameen Bank intervention also leads to significant additions to rural incomes. While the project and control villages have similar endowments of land and of male workers, average household income is found to be one-sixth higher in the project villages than in the control villages. The extreme poverty-stricken population is 48 percent among Grameen Bank participants, compared with about 75 percent among nonparticipants in the target group in both project and control villages.

Thus the Grameen Bank has made a positive contribution to the alleviation of poverty in its area of operation. But the bank has so far covered only about 4 percent of its target-group households throughout Bangladesh. The issues are whether it can be expanded to a wide-enough scale to have a significant effect on the alleviation of rural poverty in Bangladesh and whether the model can be replicated in other countries.

The main factors that could affect successful expansion of the bank are the market for nonfarm goods and services, institutional development and stability, and costs of operation.

The present weak market for nonfarm goods and services, at the low levels of income prevailing in Bangladesh, may not pose a serious problem to expansion of the bank. It is now well recognized that with agricultural growth, the market for nonfarm goods and services is stimulated through linkage effects. The Grameen Bank target group is about half of the national population, and as their incomes rise, they will start demanding each other's products and services, thus expanding the market.

Over the last three years, the bank has made good progress in building a stable institution with the capacity to maintain the present high morale of the staff. As a result of expansion, a decentralization of administration has taken place, with responsibilities and decisionmaking powers vested in a dedicated cadre of midlevel officials that was developed during the 1976-82 period of experimentation with the project. Incentives for hard work have been maintained through quick promotion and transfers based on performance in the field.

Because of intensive supervision of borrowers and participation of bank workers in social development activities, the operating costs of Grameen Bank are very high. For 1986 the cost of loan operations is estimated at 21.7 percent of the loans and advances at the actual cost of funds to the bank, which is highly subsidized by two loans from the International Fund for Agricultural Development (IFAD). This cost would be 26.5 percent if the bank had to borrow at the same rate as the other financial institutions in the country.

The implicit rate of subsidy on loan operations is estimated at 39 percent at the actual cost of the funds, and 51 percent at the opportunity cost. The bank has so far managed on its own by keeping part of its low-cost loanable funds in fixed- and short-term deposits with other banks, and the profits from these financial transactions have made up the losses from loan operations. But this practice cannot be counted on as a long-term source of income. The high cost may constrain the expansion of the bank unless it decides to increase the rate of interest charged on the loan or to reduce the cost by providing more large loans (for example, collective enterprise loans), moving into agricultural credit for small farmers, and embarking on deposit-banking on a large scale.

The Grameen Bank concept of generating self-employment for the poor through credit without collateral should work in other countries with widespread poverty and underemployment. Some elements of the Grameen Bank approach to delivery of credit, such as formation of small homogeneous groups for group guarantee of loans and supervision of loan utilization, recovery of loans in small regular installments, and development of institutions of collective savings for mutual benefit of members, may also work in other environments. But elements like taking the bank to the people and intensive interaction of bank staff with borrowers may be inappropriate and highly expensive for sparsely settled areas with underdeveloped transport systems. For such environments, an appropriate delivery mechanism has to be worked out. Indeed, one of the lessons of Grameen Bank is that an appropriate institution can be developed only after considerable experimentation, through a thorough understanding of the physical and socioeconomic environments.

2

INTRODUCTION

Bangladesh has been experimenting with a rural credit program for the extreme poor that is known as the Grameen Bank. The word *grameen* means village, but the Grameen Bank is different from the agricultural development bank (Bangladesh Krishi Bank or BKB) and commercial bank branches located in villages. The Grameen Bank is a target-group-oriented credit institution set up to provide loans to rural households that own less than 0.5 acre of land.

The Grameen Bank was initiated in 1976 as an action research project in a village near Chittagong University by a professor of economics who is currently the bank's managing director. After an experimental period of three years, the project was replicated in five districts of Bangladesh (see Figure 1) during 1979-82, in collaboration with rural branches of commercial banks and BKB, and with financial assistance from the Bangladesh Bank (the state bank of Bangladesh) and the International Fund for Agricultural Development (IFAD). The project was transformed into a specialized credit institution by a government ordinance in September 1983. Since then it has expanded rapidly. By February 1987 the Grameen Bank had opened 298 branches covering more than 6 percent of the villages in the country.

The Grameen Bank organizes the poor in groups and associations and provides credit without collateral at the same rate of interest (16 percent a year) as other commercial banks. It supervises utilization of the loans and guides borrowers (members) in all-around socioeconomic development. Loans are made to individuals for a maximum of Tk 5,000.[1] Nearly three-fourths of the borrowers are women. The bank has succeeded in recovering 98 percent of the loans and in substantially improving the economic condition of member households.

Since the Grameen Bank is a rare success story in the history of rural credit experiments in the developing world, it generates curiosity and hope in other developing countries among policymakers who would like to use credit as an antipoverty program. A thorough evaluation of the initial experience of the bank may thus be useful at this stage. Such an evaluation is the purpose of this study, which aims to describe the organization and management of the Grameen Bank, evaluate its credit operations, and assess the bank's effect on alleviation of poverty.

Sources of Information

The study was undertaken by the author in May 1985 at the request of the Grameen Bank and is a follow-up of an earlier study that investigated the performance of the bank up to the end of 1983.[2] The data were collected through field surveys of borrowers and an in-depth household survey in selected project and control villages. Data generated by the bank as a part of its management information system, which is well de-

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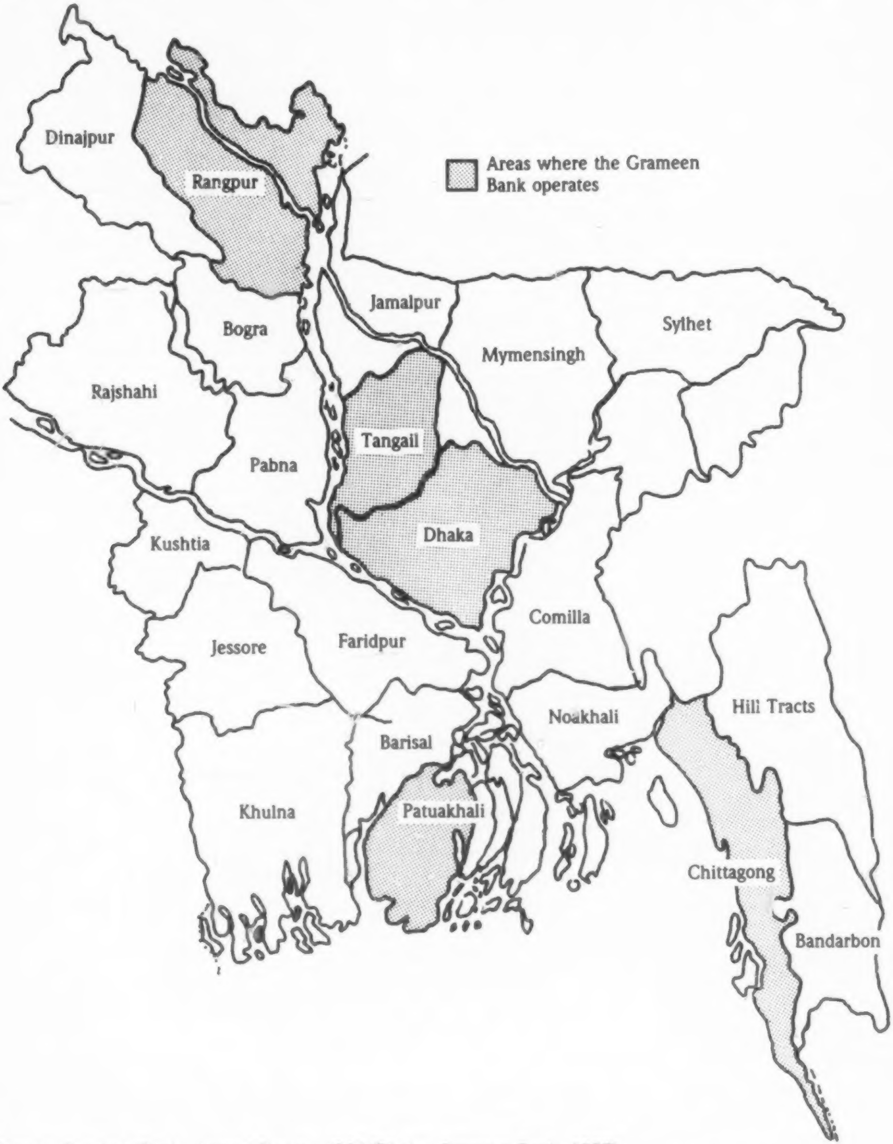
[1] In June 1987, one Bangladesh taka (Tk) was equivalent to U.S. $0.032.

[2] Mahabub Hossain, *Credit for the Rural Poor: The Grameen Bank in Bangladesh,* Research Monograph 4 (Dhaka: Bangladesh Institute of Development Studies, 1984).

Figure 1—Map of districts served by the Grameen Bank



Dinajpur
Rangpur
▨ Areas where the Grameen Bank operates
Jamalpur
Bogra
Sylhet
Mymensingh
Rajshahi
Tangail
Pabna
Dhaka
Kushtia
Comilla
Jessore
Faridpur
Noakhali
Hill Tracts
Barisal
Khulna
Patuakhali
Chittagong
Bandarbon

Source: Grameen Bank, *Annual Report, 1986* (Dhaka: Grameen Bank, 1987).
Note: An administrative reorganization in 1982 created 64 new districts out of 21 old districts.

veloped compared to that of other institutions in Bangladesh, have also been used. The survey methodology is described below.

Branches more than one year old in May 1985 were classified in two groups according to age: those from one to three years old and those more than three years old. Ten percent were randomly selected from the first group and 20 percent from the second group. This selection produced a total of 15 branches, 5 of them from the older group. A list of all villages covered by the selected branches was obtained from the Grameen Bank, and one village was randomly selected from each of the branches. All current borrowers belonging to the selected villages were interviewed, using a structured questionnaire. The sample consisted of 975 borrowers. This survey was conducted during July and August 1985.

To assess the effect of the Grameen Bank on the economic condition of borrower households, five villages selected from the older branches were taken as project villages. In addition, two control villages were selected, keeping in mind similarities of land distribution and occupation structure between project and control villages. First, a census was undertaken in these seven villages to collect information on landownership and occupation. The households were then randomly stratified into four landownership groups and two occupation groups (farm and nonfarm) within each landownership group. A proportional random sample was then drawn from each of the eight strata to get 40 sample households from each village. The total sample size for this survey thus consisted of 280 households. They were interviewed to collect detailed information on employment, assets, income, expenditure, and investment. This survey was conducted from September to November 1985, and the data refer to fiscal year 1984/85.[3] The author was involved in the design and administration of both surveys.

Organization of the Report

As a background to the study, Chapter 3 describes the socioeconomic environment under which the Grameen Bank works. Information is provided on the extent of landlessness and poverty, the organization of production and the employment situation for the poor, and the access of the poor to capital markets. This information may be useful in appreciating the factors that have contributed to the success of the Grameen Bank and the conditions for its successful replicability in other countries. Also important to the bank's success was the building of an appropriate institutional and organizational structure that could cater to the needs of the poor. The organization and management of the bank are briefly described in Chapter 4.

Historical information about the progress of the bank in disbursing and recovering loans, the relative importance of different activities financed, and the utilization of a savings fund created for the borrowers is presented in Chapter 5. Chapter 6 reports the findings of the borrower survey regarding the success of the bank in reaching its target group, the pattern of utilization of loans, and the repayment behavior of the borrowers. Chapter 7 then analyzes the effect of the bank on employment, capital accumulation, income, and the standard of living for the rural poor.

Since the Grameen Bank is an intensively managed credit program and is also engaged in socioeconomic development of its clientele, costs of operation are expected to be high. Chapter 8 takes up this issue and estimates the operating costs of the bank in order to assess the implications for subsidies in credit programs for the poor. Finally, Chapter 9 draws some lessons from the experience of the Grameen Bank and discusses both the constraints to expansion of the program and the possibility of its replication in other countries.

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[3] In Bangladesh, the fiscal year and agricultural year are the same.

3

SOCIOECONOMIC ENVIRONMENT AND THE ROLE OF CREDIT

Landlessness and Poverty

Bangladesh is an extremely land-scarce country. In 1987 it supported over 100 million people within an area of 56,000 square miles. Nearly two-thirds of its 35 million acres of land are already cultivated; the remainder is under forests, rivers, and homesteads.[4] There is little scope for expanding the cultivated area, which has remained at 22.2 million acres since the early 1960s. The 1983/84 agricultural census found that the average size of a farm had declined from 3.53 acres in 1960 to 2.25 acres in 1984.[5]

Because of the extreme pressure of population on land, the incidence of landlessness is high. In 1983/84 only 3.8 percent of rural households owned 7.5 acres or more and another 16.3 percent owned 2.5-7.5 acres (see Table 1). Households with no land at all were relatively few, since shelter requires a parcel for a homestead, but the number of marginal landowners is vast. Households with less than 0.5 acre were estimated at 6.4 million—about 46 percent of all rural households in 1983/84. In Bangladesh, households with less than 0.5 acre are considered functionally landless, since the amount of land they own cannot be a significant source of income.

Until recently, the landless were growing at a faster rate than the population—the exact magnitude of the growth is disputed because comparable time series data are not available.[6] For 1960 the number of rural households was estimated at 9.1 million, of which 3.8 million were functionally landless. By 1979 these numbers had increased to 12.9 and 6.3 million, respectively. Thus the landless grew at 2.7 percent a year compared with 1.9 percent for all rural households. In recent years, however, the situation may have improved because of rapid urbanization and relatively greater movement of the absolutely landless households to urban areas. During 1979-84, the number of absolutely landless households declined from 2.0 to 1.2 million, while the number of marginal landowners increased from 4.3 to 5.2 million—a rate of increase of 4.4 percent a year, compared with a 1.6 percent increase in the number of all rural households.

Many recent studies have reported that during the 1970s, two-thirds to three-fourths of the rural population suffered from absolute poverty, and the magnitude of poverty had deepened compared with that of the 1960s.[7] The 1970s also witnessed a severe

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[4] Bangladesh, Bureau of Statistics, *1986 Statistical Yearbook of Bangladesh* (Dhaka: Government Press, 1986).

[5] Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Government Press, 1986).

[6] Steve Jones, "An Evaluation of Rural Development Programs in Bangladesh," *The Journal of Social Studies* 6 (December 1979): 51-92; Mosharaf Hossain, A. Rashid, and S. Jahan, *Rural Poverty in Bangladesh: A Report to the Like-Minded Group* (Dhaka: Universities Research Center, 1986); and Mahabub Hossain, "A Note on the Trend of Landlessness in Bangladesh," *The Bangladesh Development Studies* 14 (June 1986): 93-100.

[7] A. R. Khan, "Poverty and Inequality in Rural Bangladesh," in *Poverty and Landlessness in Rural Asia,* ed. International Labour Organisation (Geneva: ILO, 1977), 137-160; M. Muqtada, "Poverty and Inequality: Trends and Causes," in *Bangladesh: Selected Issues in Employment and Development,* ed. R. Islam and M. Muqtada (New Delhi: International Labour Organisation, Asian Employment Program, 1986), pp. 41-60; and I. Islam and H. Khan, "Income Inequality, Poverty and Socio-Economic Development in Bangladesh," *The Bangladesh Development Studies* 14 (June 1986): 75-92.

Table 1—Distribution pattern of rural landownership, 1979 and 1983/84

Size of Land Owned	1979 Land Occupancy Survey: Number of Households	1979 Land Occupancy Survey: Share of Households	1983/84 Agricultural Census: Number of Households	1983/84 Agricultural Census: Share of Households	Annual Rate of Growth, 1979-84
(acres)	(thousands)	(percent)	(thousands)	(percent)	
None	1,979	15.4	1,198	8.7	−10.5
Less than 0.50	4,286	33.3	5,201	37.6	4.4
0.50–0.99	1,516	11.8	1,660	12.0	2.0
1.00–2.49	2,660	20.7	2,979	21.6	2.5
2.50–4.99	1,436	11.2	1,598	11.6	2.4
5.00–7.49	501	3.9	650	4.7	6.0
7.50–14.99	374	2.9	415	3.0	2.4
15.00 or more	114	0.9	117	0.8	0.6
Total	12,866	100.0[a]	13,818	100.0	1.6

Sources: Bangladesh, Bureau of Statistics, *Statistical Pocket Book of Bangladesh, 1985* (Dhaka: Government Press, 1985), p. 211; and Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Government Press, 1986), p. 98.

[a] Parts do not add to total because of rounding.

downward trend in real wages for agricultural workers. However, the 1981/82 Household Expenditure Survey shows significant improvement in the poverty situation in the early 1980s.[8] The real wage for agricultural laborers also has shown a consistent upward trend since 1982. In 1986 the daily nominal wage could buy 3.5 kilograms of rice—44 percent more than during the 1975-82 period, and 25 percent more than in 1970, just before the independence of the country. But the proportion of poor population was still about 60 percent in 1981/82, which must be considered high by any standard.

The links between landlessness and poverty are widespread underemployment and low productivity of labor. The labor force surveys in Bangladesh report very little open unemployment (Table 2), because people often find part-time and short-duration work and family laborers share work generated by the household. The average duration of work is also estimated at high levels. The 1983/84 labor force survey recorded that in rural areas, an employed person worked an average of 52 hours during the week preceding the date of the survey.[9] But a large proportion of such labor would be of very low productivity. Since the poor cannot afford to remain unemployed, and the wage rate is low, they engage in various types of self-employment and work beyond normal hours to supplement their meager household income.

Farming as a Source of Employment

The labor-absorption capacity of the agricultural sector is limited. Seventy-nine percent of the labor force reported agriculture as their primary occupation in 1974, but many have since moved out of agriculture, reducing its share to 59 percent by 1983/84 (Table 2). Agriculture's share of the rural labor force declined from 86 percent to 72 percent during 1974-84. Information on national employment in crop farming is lacking. Based on norms of fixed labor coefficients derived from village studies, it is estimated that an agricultural

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[8] Bangladesh, Bureau of Statistics, *Report of the Bangladesh Household Expenditure Survey, 1981-82* (Dhaka: Ministry of Planning, 1986).

[9] Bangladesh, Bureau of Statistics, *Final Report: Labor Force Survey, 1983-84* (Dhaka: Government Press, 1986).

Table 2—Changes in structure of labor force, 1973/74 to 1983/84

Labor Category	1973/74 Millions of Persons	1973/74 Share of Total	1983/84 Millions of Persons	1983/84 Share of Total	Annual Rate of Growth
		(percent)		(percent)	(percent)
Labor force	21.93	100.0	28.47	100.0	2.7
Unemployed	0.52	2.4	0.49	1.7	−0.6
Employed	21.41	97.6	27.98[a]	98.3	2.7
Rural	19.20	87.6	22.20	78.0	1.5
Urban	2.21	10.0	5.80	20.3	10.1
Employed in nonagriculture	4.57	20.8	11.53	40.5	9.7
Rural	2.67	12.3	6.25	22.0	8.9
Urban	1.90	8.5	5.28	18.5	10.8

Sources: Bangladesh, Bureau of Statistics, *Final Report: Labor Force Survey, 1983-84* (Dhaka: Government Press, 1986).

Note: The 1983/84 figures have been adjusted to include rural towns in urban areas. The 1973/74 figures are adjusted for undercounts detected in the postcensus enumeration checks.

[a] Parts do not add to subtotal because of rounding.

worker would have been employed in crop farming for 158 days during 1984/85.[10]

The wage employment generated in farming activities is even less adequate for functionally landless (less than 0.5 acre) households. The small farm (less than 2.5 acres) can meet most of the required labor with family workers, and large landowners (with 7.5 acres or more) cultivate a part of their holdings with peasant sharecroppers, thereby reducing the need to hire labor. Thus the size of the agricultural labor market is small and is gradually shrinking because of the increasing availability of family workers associated with the growing pressure of population on land. It is estimated from a recent household survey that nearly four-fifths of farm households hire labor at some time because of the seasonality of agricultural operations, but only one-fourth of the available agricultural labor is hired.[11] On the supply side, two-thirds of the functionally landless households participate in the agricultural labor market, and the participating households receive employment from the market for about 160 days a year.

With existing technology, labor productivity in farming is low and payment to hired labor is meager. In 1984/85, value added from crop production was Tk 15,000 per farm household against an estimated employment of 225 days per farm, which gives a labor productivity of Tk 67 per eight-hour standard day. At this rate, a six-member farm household would have to work for 310 days to earn a poverty-level income for the household. The hired workers are paid a wage rate that is less than a half of the average labor productivity. The nominal wage rate for agricultural workers in 1984/85 was Tk 25 per day. At this rate, a five-member landless household would have to work for 690 days a year to earn the poverty-level income. This amounts to about 400 days per worker in the household.[12] The compulsion on the part of the poor to generate self-employment so that they can utilize available surplus labor and can work beyond standard hours is thus understandable.

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[10] M. Muqtada, "Determinants and Possibilities of Employment Expansion in the Crop Sector," in *Bangladesh: Selected Issues in Employment and Development,* ed. R. Islam and M. Muqtada (New Delhi: International Labour Organisation, Asian Employment Program, 1986), pp. 61-88.

[11] Mahabub Hossain, *Nature and Impact of Modern Rice Technology in Bangladesh,* Research Report 68 (Washington, D.C.: International Food Policy Research Institute, forthcoming).

Agricultural Growth Linkage and Expansion of the Rural Nonfarm Sector

In view of the above, it could be argued that the landless are being pushed out of agriculture and that the urban informal sector and the rural noncrop activities are operating as their "employers of last resort." These activities enable labor-surplus households to transform nonmarketed labor into commodities and marketable services. The expansion of the rural nonfarm sector would then be constrained from the demand side. If the demand for nonfarm goods and services did not increase as fast as the supply, prices would fall and the increased flow of labor into the sector would reduce labor productivity.

Agricultural growth following the diffusion of the new "seed-fertilizer-water" technology may, however, stimulate the demand for nonfarm goods and services.[13] In Bangladesh, regional concentration of irrigation and the availability of the new technology mostly for rice and wheat has led to specialization of cereal production in irrigated areas and production of noncereal crops in nonirrigated areas. This implies larger movement of agricultural commodities across regions and increased demand for trading and transport services. The diffusion of the new technology may have created opportunities for investment in rural nonfarm activities through its effect on the demand for (1) agricultural inputs such as fertilizer, pesticides, irrigation equipment, fuel, and spare parts produced in the nonagricultural sector; (2) services for processing and marketing additional surplus produce; and (3) trading and transport services to handle the additional purchase of nonfarm goods. Also, livestock and fisheries products and rural services have very high income elasticity of demand, so with the growth of agricultural income the share of these commodities in the rural consumption basket increases more than proportionately.[14]

Rapid rural-urban migration itself creates jobs in the rural nonfarm sector. In Bangladesh, urbanization is going on at a rapid pace. The proportion of urban population increased from only 5 percent in 1961 to 17 percent in 1981. The enlarged urban market has stimulated the growth of marketed surplus and increased the flow of urban goods to rural areas. The marketed surplus of rice increased from about 10 percent in the early 1960s to nearly 40 percent in 1984/85.[15] According to a recent transport study,[16] the volume of freight traffic increased by 5 percent a year and the volume of passenger traffic by 7 percent a year during 1976-85. The demand for trading and transport services would increase correspondingly.

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[12] The average size of the household and number of family workers assumed for this calculation are those observed in village studies. The poverty level income for 1984/85 is taken as 10 percent higher than that estimated for 1983/84. The retail price of coarse rice has actually increased in recent years by about 10 percent a year.

[13] John W. Mellor, *The New Economics of Growth* (Ithaca, N.Y.: Cornell University Press, 1976).

[14] For rural Bangladesh, the expenditure elasticity of demand is estimated at 1.6 for livestock and fisheries products, 1.4 for industrial goods, and 1.6 for construction, trading, transport, and other services, compared to 0.7 for food crops. See Mahabub Hossain, "Agricultural Growth Linkages—The Bangladesh Case," *The Bangladesh Development Studies* 15 (March 1987): 1-30.

[15] Bangladesh, Bureau of Statistics, *Monthly Economic Situation in Bangladesh* (Dhaka: Government Press, December 1985); and Bangladesh, Bureau of Statistics, *Master Survey of Agriculture (Second Round)* (Dhaka: Government Press, 1964).

[16] Bangladesh, Planning Commission, "Intermodal Transport Study: Final Report," as quoted in *The Third Five-Year Plan, 1985-90* (Dhaka: Government Press, December 1985).

Organization of Nonfarm Production and the Poor

A majority of the organizers of rural nonfarm activities come from lower-income households. According to the 1983/84 agricultural census,[17] 6.7 percent of rural households operated cottage industries; the proportion was 10.8 percent for the landless, 6.9 percent for those operating less than 2.5 acres, and 3.7 percent for households operating 7.5 acres or more. A 1982 survey of 16 villages found that 40 percent of rural households were engaged in transport and construction activities and 30 percent in various rural services.[18] For the functionally landless group, the estimate was 54 percent in transport and construction and 40 percent in rural services. The inverse relationship between self-employment in rural nonfarm enterprises and the size of landownership has also been reported by other village studies.[19]

A number of hypotheses can be put forward to explain the relative advantages, in the initial stages of development, of small-scale organization of production around the household over large-scale production along capitalist lines.

First, at low levels of income, the size of the market for nonfarm goods and services is so small and thinly spread over a wide area that large-scale organization of production may be uneconomic owing to underutilization of capacity of indivisible assets. For example, a petty trader carrying goods on a headload may operate more economically in a village *hat* than a large trader transporting goods on carts, boats, or trucks. (A *hat* is a marketplace where people assemble once or twice a week. On average, one *hat* serves a population of about 9,000 people from a cluster of eight villages.)

Second, in the environment of underdeveloped infrastructure facilities, the high unit cost of transport may prohibit movement of goods necessary to exploit the market of a wider area if production has to be organized on a large scale. The household, on the other hand, can limit production to an amount that can be sold within the locality or be transported to the *hat* on headloads of the producer without incurring any transport cost. This may be an important reason behind the dispersion of traditional cottage occupations, such as potter, blacksmith, carpenter, and matmaker, to almost every village, thus making each village a self-sufficient production and consumption unit at the phase of development when the market is thin and the infrastructure is undeveloped.

Third, the demand for such goods and services may be seasonal, with peaks occurring during post-harvest periods when farmers sell their products and buy nonfarm goods with the cash income. Trading activities fluctuate even within a week; in most areas, transactions take place in a *hat* held once or twice a week. In this environment, the household has more flexibility in reallocating family labor among different occupations according to the pattern of demand than does a firm hiring workers on a full-time basis. Thus, a hired worker of a specialized firm is more likely to be underemployed than is a family worker engaged in a number of activities that the household organizes.

Fourth, under conditions of widespread underemployment and poverty, the opportunity cost of employing family labor may be considerably less than the wage rate. Because of institutional norms, hired laborers work for a specified period of the day (usually from eight o'clock in the morning to four in the afternoon). But a household that attaches high cost to leisure because of poverty can extend working hours by employing family workers beyond normal hours. Maintenance of livestock and poultry is an activity that can be done by using family labor during slack times without sacrificing the opportunity of wage employment. In Bangladesh, a large proportion of workers in cottage industries are women who, because of socioreligious factors, do not look for employment outside the home. Cottage industries and petty trade are often secondary occupations of men who work during evenings or slack periods of their primary occupation.[20] Since such family labor has low opportunity cost, the real rate of return on capital for organizing nonfarm activities is higher for a household than for a firm that must deduct the wages paid to hired workers before estimating the profit.

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[17] Bangladesh, *Census of Agriculture and Livestock: 1983-84.*

[18] Hossain, *Nature and Impact.*

[19] See, for example, Bangladesh Institute of Development Studies, *Rural Industries Study Project—Final Report* (Dhaka: BIDS, 1981), Chap. 3.

The Role of Credit

Generation of self-employment in nonfarm activities may require investment in working capital and basic skills in reading, writing, and arithmetic. The poor may be constrained in taking up such employment opportunity by lack of financial resources and necessary human capital. The amount of financial capital required may be small, but at very low levels of income it is difficult to accumulate even that amount. Although development of human capital involves a long-term program, working capital can be provided to the poor through financial institutions.

Under certain circumstances, loans can help the poor to accumulate their own capital. Baker and Hopkin show that the relationship between the growth in equity capital and credit is governed by the following:[21]

$$\Delta E/E = [(D/E)(r - i) + r]\,(1 - c),$$

where D is the amount of loan; E is the amount of equity capital, that is, the difference between the value of assets and the loan; r is the rate of return on assets; i is the rate of interest paid on the loan; and c is the rate of consumption out of the income from the asset. As long as the rate of return on assets is higher than the rate of interest on the loan, credit will increase family income. The higher the share of the loan in total capital (D + E), the higher will be the growth of income of the household. If the marginal propensity to consume is unity, the amount of equity capital will be unchanged, but if it is less than one, the loan will increase the net worth of the household. Under normal circumstances, the poor may find it very difficult to save, but if the credit program is such that the loan and the interest are recovered in small installments over a period of time, the loan may force compulsory regular saving of small amounts that would otherwise be consumed under the pressure of poverty.

But credit is rarely available to the poor at reasonable rates of interest. Commercial banks fail to cater to the credit needs of the poor for three main reasons. First, these banks require collateral, which the poor find difficult to provide; second, their procedures for filling in application forms and completing other formalities for obtaining loans are too cumbersome for the illiterate poor; and third, they prefer handling large loans rather than the petty loans that the poor need. The general experience of the small farmer credit program, which has long been popular with governments of most developing countries, has been limited success in reaching the target group.[22]

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[20] The 1979 BIDS survey of rural industrial enterprises in 11 *upazilas* (the lowest-level administrative unit, which was previously called *thana)* found that women constituted 34 percent of workers in enterprises located in villages, compared with only 6 percent in enterprises located in rural towns. Male workers employed in rural industries worked an average of 319 days a year, of which 188 days (59 percent) were spent in industrial occupations. In low-productivity industries, such as mat making, bamboo and jute processing, and rice processing by wooden husker, industry provided employment to male workers for 125 days. Female workers, on the other hand, worked for 287 days a year, of which 276 days (96 percent) were spent in industrial occupations. See Mahabub Hossain, "Employment and Labour in Bangladesh Rural Industries," *The Bangladesh Development Studies* 12 (March-June 1984): 1-24.

[21] C. B. Baker and J. A. Hopkin, "Concepts of Finance Capital for a Capital-Using Agriculture," *The American Journal of Agricultural Economics* 51 (December 1969): 1055-1064.

In Bangladesh the number of rural branches of commercial banks and the agricultural development bank has increased greatly in recent years, from 854 in 1975/76 to 3,225 in 1983/84.[23] The amount of credit disbursed by these institutions increased from Tk 461 million to Tk 10,087 million during this period, but the loans were received by a few medium and large landowners. A survey conducted by the International Fertilizer Development Center (IFDC) among 2,400 randomly selected households noted that in the 1982 boro rice season (when the input-intensive, high-yielding paddy is grown), only 4.6 percent of the farmers received credit from institutional sources. The proportion was 1.2 percent for farmers with landholdings of less than 1.0 acre, compared with 7.7 and 7.2 percent, respectively, for farmers with medium (2.5 to 5.0 acres) and large (over 5.0 acres) holdings.[24] The picture was similar for other crop seasons. For the 1981/82 crop year, 13.6 percent of the farmers received credit from institutional sources; for the marginal landowning group, the estimate was 5.4 percent.

The joint review of agricultural credit conducted by the government of Bangladesh and the International Development Association also noted that loans disbursed by financial institutions went mostly to households owning 3 to 9 acres of land.[25] The findings of a 1982 household survey conducted jointly by the Bangladesh Institute of Development Studies (BIDS) and the International Food Policy Research Institute (IFPRI) in 16 villages are reported in Table 3.[26] The survey collected information on a quarterly basis on loans obtained by the sample households from both institutional and informal sources. It was found that only 14 percent of the households received credit from institutional sources; this is similar to the findings of the IFDC survey.[27] The institutional sources provided one-fourth of the total loans taken by the sample households. Only 7 percent of the functionally landless group could tap the institutional sources, which accounted for 8 percent of the total loans taken by them. The extremely limited access of the poor to financial institutions is aptly demonstrated by the above information.

The poor, however, have access to informal sources of loans: professional moneylenders known as *mohajons,* well-to-do farmers, friends, and relatives. Table 3 shows that 62 percent of the rural households obtained loans from these sources, and their importance was higher for the smaller landowning groups. Nearly 92 percent of the functionally landless households were dependent on these sources for about 92 percent of total loans. But these sources charge very high rates of interest. The BIDS/IFPRI study[28] found that in two-fifths of the cases, loans from informal sources were provided

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[22] For an excellent review of the small farmer credit program in developing countries, see U.S. Agency for International Development, *Small Farmer Credit: Analytical Papers,* vol. 19 (Washington, D.C.: Department of State, 1973).

[23] A. M. A. Rahim, "Agricultural Credit Institutions and Policies in Bangladesh," *The Bangladesh Journal of Agricultural Economics* 8 (June 1985): 17-34; Mahabub Hossain, "Institutional Credit for Rural Development: An Overview of the Bangladesh Case," *The Bangladesh Journal of Agricultural Economics* 8 (June 1985): 1-16.

[24] International Fertilizer Development Center, *Agricultural Production, Fertilizer Use and Equity Considerations: Results and Analysis of Farm Survey Data; 1980-82, Bangladesh* (Muscle Shoals, Ala.: IFDC, 1984), pp. 67-70.

[25] Bangladesh/International Development Association, *Bangladesh Agricultural Credit Review* (Dhaka: Government of Bangladesh/IDA, 1983).

[26] For details about the survey see Bangladesh Institute of Development Studies/International Food Policy Research Institute, *Development Impact of the Food for Work Program in Bangladesh,* a report prepared for the World Food Programme (Washington, D.C.: BIDS/IFPRI, 1985).

[27] IFDC, *Agricultural Production.*

[28] BIDS/IFPRI, *Development Impact of the Food for Work Program.*

Table 3—Distribution pattern of rural credit, by landownership group, 1982

Landownership Group	Households Receiving Loans		Amount of Loans Obtained per Household		Share of Total Loans Obtained from Institutional Sources
	Institutional Sources	Informal Sources	Institutional Sources	Informal Sources	
(acres)	(percent)		(Tk/year)		(percent)
Functionally landless (up to 0.49)	6.8	91.6	81	936	8.0
Small owner (0.50–1.99)	15.0	55.9	226	841	21.2
Medium owner (2.00–4.99)	20.0	46.9	504	963	34.4
Large owner (5.00 or more)	21.0	29.0	929	1,493	38.4
All households	14.3	61.7	323	964	25.0

Sources: Compiled from information in Raisuddin Ahmed and Mahabub Hossain, "Infrastructure and Development of a Rural Economy," International Food Policy Research Institute, Washington, D.C., 1987 (mimeographed).

Note: These figures are estimates based on a survey of 640 randomly selected households in 16 villages that was conducted jointly by the Bangladesh Institute of Development Studies and the International Food Policy Research Institute in 1982.

free of interest,[29] but for the remaining cases the average rate of interest charged was estimated at 125 percent a year. In contrast, the average rate of interest paid on loans from institutional sources was 14.6 percent a year. The high rate of interest severely limits the production activities that can be undertaken with the loans. Therefore, high-interest credit from noninstitutional sources basically finances consumption, for which the poor are forced to take very short-term loans when their physical existence is at stake.

Faced with shortage of capital, many nonfarm operators often borrow raw materials in kind from the *mohajons* against the stipulation of compulsory delivery of output to the lender. Such transactions usually involve higher prices for raw materials and lower prices for output, compared with the market, and the implicit interest charges claim a large proportion of the potential income of the borrower.[30] Also, lack of access to capital sometimes forces the poor with necessary skills to organize nonfarm enterprises in "partnership" with the rich whose only involvement in the activity is the contribution of capital. The income obtained by the poor in such enterprises may not be higher than the imputed value of the family labor at the wage rate prevailing in the market. Supply of capital at "reasonable" rates of interest could thus make a significant dent in the life of the rural disadvantaged groups.

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[29] Raisuddin Ahmed and Mahabub Hossain, "Infrastructure and Development of a Rural Economy," International Food Policy Research Institute, Washington, D.C., 1987 (mimeographed).

[30] The Bangladesh Institute of Development Studies survey of rural industrial enterprises estimated the annual rate of interest at 58 percent for loans supplied by local moneylenders and 48 percent for loans obtained from rich peasants. See Momtaz U. Ahmed, "Financing Rural Industries in Bangladesh," *The Bangladesh Development Studies* 12 (March-June, 1984): 59-79. The high rate of interest in informal markets is generally explained by the scarcity of capital, high costs of administering loan recovery, high risks of default, seasonal demand for credit, and in certain cases, a monopoly rent. See, among others, Anthony Bottomley, "Monopoly Profits as a Determinant of Interest Rates in Underdeveloped Rural Areas," *Oxford Economic Papers* 16 (November 1964): 431-437; and Millard Long, "Interest Rates and the Structure of Agricultural Credit Markets," *Oxford Economic Papers* 20 (July 1968): 275-288.

4

ORGANIZATION AND MANAGEMENT OF THE GRAMEEN BANK

Origin of the Bank

The Grameen Bank originated from a small action-research project undertaken in 1976 by a professor of economics in a village called Jobra, near Chittagong University. The project aimed to test the hypothesis that if financial resources are made available to the poor at reasonable terms and conditions, they can generate productive self-employment without external assistance. The professor had observed that a large proportion of the extremely poor households in the village were engaged in various nonfarm activities with a meager amount of capital borrowed from informal sources. The small size of the loans and the high rate of interest (10 percent a month) did not enable the poor to improve their living standard and accumulate capital of their own.

A local branch of a commercial bank was authorized to provide credit at an interest rate of 13 percent a year. When the professor approached this bank on behalf of the poor, the bank at first refused credit because of lack of collateral. After much persuasion, the bank agreed to provide loans to the poor, but the professor had to guarantee recovery. From this experience came the idea of the action research project and development of an appropriate mechanism for ensuring timely recovery of loans.

To convince the bankers that it was safe to extend credit to the poor without collateral, the professor proposed to the managing director of the agricultural development bank (BKB) that the professor be given the responsibility of operating a branch under the director's guidance. A suboffice of a branch was set up in March 1978 to allow the professor to experiment with his ideas about the appropriate mechanism for delivery of credit to the poor. This pilot experiment was successful, and with financial assistance from the Bangladesh Bank, the Grameen Bank Project was launched in June 1979 to see whether the experiment could be replicated in a wider area.[31] The project was located in Tangail District, far away from Chittagong University, and was tied in with local branches of the nationalized commercial banks and BKB. Within a year, 24 branches were set up—19 in Tangail District and 5 in Chittagong District. The project was further modified and developed through experiments. It ensured 98 percent recovery of loans at due date. But lack of enthusiasm from the participating banks constrained its further expansion. So a loan was arranged from IFAD, and the project was further extended to Dhaka, Rangpur, and Patuakhali districts. Between April 1982 and June 1983, 50 new branches were set up in these five districts.

A government ordinance in September 1983 transformed the project into the Grameen Bank, a specialized financial institution for the rural poor. The ordinance provided for an authorized capital of Tk 80 million[32] and paid-up share capital of Tk 30 million, and an ownership pattern of 60 percent with the government and 40 percent with the borrowers. By an amendment of the ordinance in July 1986, the paid-up share capital was raised to Tk 72 million, of which the Grameen Bank borrower-shareholders would subscribe to 75 percent and the government to 25 percent.

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[31] The objectives behind the Grameen Bank Project are explained in Muhammad Yunus, *Grameen Bank Project in Bangladesh: A Poverty Focussed Rural Development Program* (Dhaka: Grameen Bank, 1982); and Muhammad Yunus, "Experiences in Organising Grass Root Initiatives and Mobilising People's Participation: The Case of Grameen Bank Project in Bangladesh," paper presented at the 25th World Conference of the Society for International Development, Baltimore, Md., 1982.

[32] At the 1986 official rate of exchange, U.S. $1.00 = Tk 30.00.

Organizational Structure

The managing director is the chief executive of the bank. The 1983 Grameen Bank ordinance stipulates a board of governors composed of the chairman, the managing director, and nine other members—five appointed by the government and four appointed by the borrower-shareholders. The 1986 amendment of the ordinance provides for 13 members of the board, of which 9 are to be selected from the borrower-shareholders. The board approves the policies of the bank and serves as the link between the bank, the Ministry of Finance, and other government organizations.

The branch office is the lowest administrative unit of the Grameen Bank and is considered the profit-responsibility unit. For accounting purposes, the bank charges 10 percent interest on the funds it lends to branch offices for disbursement to the borrowers at an annual interest rate of 16 percent. Hence a branch office is encouraged to keep its cost of operation at or below 6 percent of the amount of outstanding loans. The amount of profit earned is an important criterion for evaluating the performance of the branch staff. About 10 to 15 branch offices are supervised by an area office, which is usually located in a small town. The area manager is the final authority for approval of loans and supervises loan utilization and recovery with the help of a number of program officers. The area offices are accountable to the zone office located in the district headquarters. The zone manager is responsible for handling accounts and managing funds. Recently the zone office has also taken responsibility for monitoring, evaluating, and supervising the social development programs. A zone manager works in close contact with the area managers, who attend management meetings once or twice a month in the zone office.

The head office, located in Dhaka, basically maintains liaison with the government and provides feedback to lower-level offices. It is also responsible for supervising the training of bank staff and for research and development activities.

Initially there were only the head office and the branch offices. With the increase in the number of branch offices and expansion of the bank in a number of districts, the zone offices were created. Area offices were created when the number of branch offices grew beyond the capacity of a zone office to supervise. As the number of branches increases, the zone grows horizontally, and when it reaches a critical size a new zone is created.

With rapid expansion of the bank, management functions and decisionmaking powers are gradually delegated to lower levels. Most of the functions of the head office were assigned to zone offices when they were established. The zone offices delegated to area offices the power of account supervision and loan approval. Social development programs were initially located at the head office, but authority for these was soon transferred to zone offices, and zone offices are now planning to transfer responsibility for these programs to area offices. In this process of horizontal growth and decentralization of power, the head office becomes a secretariat or information clearinghouse. Ultimately it retains functions such as monitoring and evaluation, research and development, supervision of training, and similar activities that benefit from access to information from different operational areas.[33]

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[33] For an excellent account of the organizational development and the functions of the bank, see Andreas Fugelsang and Dale Chandler, *Participation As Process—What We Can Learn from Grameen Bank, Bangladesh* (Oslo: Norwegian Ministry of International Development, 1987). This section draws heavily from the report.

Formulation and change of policies are arrived at by a consensual approach through meetings of the managing director with the heads of various departments located in the head office and with zone managers. The managing director meets with the zone managers twice a year to exchange experiences and discuss issues for further development of the bank. The meetings may continue for up to three days. The branch managers are encouraged to try their own ideas in the field, and if successful, to pass them on to higher levels for testing and development and ultimately for replication in other areas. Innovative ideas are also taken from the borrowers when their representatives attend workshops for an exchange of views among themselves and with higher bank officials. A substantial part of the managing director's time is spent traveling in the field to maintain contact with borrowers and with staff of the branch offices.

Mode of Operation

The Grameen Bank now follows standard operational procedures that evolved throughout the 1976-83 period in a process of continuous interaction with the poor. A Grameen Bank branch normally covers an area of about 15 to 20 villages located in a union, or at most two unions, in the vicinity of the branch. The branch is headed by a branch manager and includes six bank workers, an accountant, and one or two bank assistants. A person from a household that owns less than 0.5 acre of cultivated land, or assets with a value equivalent to less than 1.0 acre of medium-quality land, is eligible to receive a loan. (The original project eligibility limit of 0.4 acre of cultivated land was revised upward by the Grameen Bank Ordinance of 1983.) Because most members of the target group are illiterate and are shy about coming to banks, the banking services are brought to their doorsteps. The size of the branch and the area covered is determined by the bank workers' daily travel to maintain contact with the target group. In most cases, because of underdeveloped roads and transport facilities, the bank workers have to walk.

When the Grameen Bank decides to open a branch, the first task of the branch manager is to prepare a socioeconomic report covering the geography, economy, demography, transport and communication infrastructure, and political power structure of the area to be covered by the branch. The bank manager thus becomes acquainted with the locality and the people before starting operation. When the report is approved by the head office, the manager arranges a general public information meeting, inviting all classes of people in the locality. At the meeting the manager introduces bank officials and explains the Grameen Bank's purpose, rules, and programs. The local elites realize that the initiative is for the benefit of the poor only, and the poor understand that in order to receive loans they will have to organize themselves in groups and associations and interact with each other. The bank's operation starts after the meeting.

Interested persons are asked to form groups of five like-minded people of similar economic standing who enjoy mutual trust and confidence. The bank has settled on a group of five through trial and error. Initially, loans were given to individuals, but that quickly proved to be uncontrollable for the staff. Then groups of 10 or more were organized and the idea of mutual responsibility was introduced, but that size turned out to be too large to have the informal relationship among members that is necessary for mutual responsibility to be effective. In the end, five members proved to be the most practical size.[34]

Only one person from a household can be a member,[35] and relatives must not be in the same group. Male and female members form separate groups. Each group elects a chairperson and a secretary, and these positions rotate among members on a yearly basis so that all members have the learning experience that accompanies the responsibilities of these positions. The chairperson is responsible for discipline in the group and for supervision of loan utilization by the members. Members conduct business with a bank worker, through the chairperson, at weekly meetings that all members are obliged to attend.

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[34] Ibid., p. 57.

[35] Initially, a number of persons from the same household could receive loans from the bank, provided they belonged to different groups. But in 1982 the policy was changed in view of the experience that such households faced difficulty in effective utilization of the loans and repayment of installments. The present policy is to provide a loan to only one member of a household, and preferably to a female member.

A number of groups from the same village are federated into a center and the weekly meetings are held at the center level. Again, groups of male and female members form separate centers. The group chairpersons elect a center chief and a deputy center chief, who hold office for one year only. Center chiefs ensure attendance at the weekly meetings, payment of loan installments, and overall discipline, and conduct the program of the meetings. The bank worker attends the center meetings, and all bank business is conducted openly in the meeting in front of the members.

Loans are given to individuals (for a maximum of Tk 5,000) without any collateral. A borrower may use the credit in any productive activity, but the loan has to be used immediately and the principal repaid in 50 weekly installments.

Disbursement of loans is not a simple matter. When a group is formed, it is kept under close observation for a month by the bank worker to see if members are conforming to the discipline of the Grameen Bank. The prospective borrowers are obliged to participate in a group training program for a minimum of seven days of continuous instruction by the bank worker. The training is intended to make the members thoroughly conversant with the rules and regulations of the bank. This includes understanding the purpose of the various bank procedures; the responsibilities of the group chairperson and the center chief; the group savings program; health, children's education, and other social development programs; and learning to make signatures. The group is accorded formal recognition when all members are found to be well versed in the rules and procedures. Two members of the group then receive loans and their loan-repayment behavior is observed for a month or two. If they pay the weekly installments on a regular basis, the next two members become eligible for loans. The group chairperson is the last member to receive a loan. A repeat loan is not approved for any member until the accounts of all members of the group are settled.

The group functions as an institution to ensure mutual accountability. The individual is kept in line by a considerable amount of pressure from other members of the group. The existence of the group thus acts as the collateral for the bank loans. The credibility of the group as a whole and its future benefits in terms of new loans are in jeopardy if one member breaks the discipline and defaults on loan repayments. So groups sometimes decide to fine or to expel a member who fails to attend a meeting and willfully defaults on payment of installments. Other members of the group also extend financial support to a member in times of genuine difficulty when the member cannot pay the installment. A member may leave the group when the loan is fully repaid; if a member leaves earlier, the responsibility for paying the balance falls to the remaining group members. When an entire group defaults, the responsibility of repayment falls to the center.

One of the regulations of the Grameen Bank is that each member must save one taka every week besides 5 percent of the loan amount, which is kept aside at the time of disbursement. The savings are accumulated in the Group Fund. This account is managed by the group on a consensual basis, thus providing the members with an essential experience in the collective management of finances. A member who leaves a group is entitled to withdraw the personal weekly savings accumulated in the fund, but cannot reclaim the 5 percent deducted from the loans. When forming a group, all members sign an agreement to that effect. The amount collected from fines imposed on members for breach of discipline is also accumulated in the Group Fund for the benefit of all members. This amount is deposited with Grameen Bank at 8.5 percent annual interest.

A member can borrow from the Group Fund for consumption at times of sickness or social ceremony, so that it is not necessary to take these expenses out of capital or go back to the informal markets for such loans. Group Fund loans for investment are also allowed if all members of the group agree. The group decides the terms and conditions of these loans, which are normally granted interest-free.

It is often argued that the poor value credit from informal sources more highly than from financial institutions because they perceive the informal lender as a permanent and reliable source available to finance consumption as well as production expenses.[36] By creating the Group Fund, the Grameen Bank has ensured the same flexibility in its credit services as in the informal markets.

Each borrower is also obliged to pay a sum equivalent to 25 percent of the amount charged by the bank as interest. This amount is accumulated in the Emergency Fund created for insurance coverage in case of default, death, disability, or other unforeseen events. This fund is managed by members at the center level and requires the joint signatures of the center chief, deputy center chief, and bank manager for its operation. On behalf of a member, the group can claim from the Emergency Fund up to Tk 2,500, or 50 percent of the amount accumulated by the member, whichever is less. The disbursements from the Emergency Fund have so far been negligible. The bank is studying various plans for effective utilization of the fund.

Beginning in 1984, a social development program called "Sixteen Decisions" was introduced by the bank to imbue members with discipline, unity, and hard work and to improve their living standard. These decisions include certain codes of conduct that members are encouraged to follow in their daily life, such as production of fruits and vegetables in kitchen gardens, investment for improvement of housing and education of children, use of latrines and safe drinking water for better health, and rejection of dowry in marriages (see Figure 2). Physical training and parades are held in weekly center meetings for both men and women, and the "Sixteen Decisions" are chanted as slogans. The bank management says that observance of these decisions—including participation in physical training and parades—is not compulsory, but in the field their observance has become a requirement for receiving a loan.

With the introduction of "Sixteen Decisions," the Grameen Bank has moved into an overall development program for the poor. Credit has been an entry point and now serves as a catalyst in the development process. The managing director, however, emphasizes the bank's interest in the social development program. In the long run, better housing and sanitation, and increased consumption of vegetables and fruits improve the health of the borrower, increase his productivity and income, and hence ensure better recovery of loans. Development of kitchen gardens provides a regular source of income from which the borrower can partly finance the weekly installments. Dowry constitutes the greatest risk of default in repaying loans, as the poor borrower is under compulsion to use capital to finance it. The bank is working hard to do away with this social ill and the attendant economic burden on its members. Recently, children's education has been promoted through active help in establishing center schools, distributing textbooks, and setting up children's savings and funds, since basic skills in reading, writing, and arithmetic are required for increasing the productivity of labor.

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[36] C. B. Baker, "Role of Credit in the Economic Development of Small Farm Agriculture," in U.S. Agency for International Development, *Small Farmer Credit: Analytical Papers,* vol. 19, SR 119 (Washington, D.C.: USAID, 1973), pp. 41-70.

Figure 2—The "Sixteen Decisions" program

Sixteen Decisions

1. The four principles of Grameen Bank—discipline, unity, courage, and hard work—we shall follow and advance in all walks of our lives.
2. We shall bring prosperity to our families.
3. We shall not live in dilapidated houses. We shall repair our houses and work towards constructing new houses as soon as possible.
4. We shall grow vegetables all the year round. We shall eat plenty of them and sell the surplus.
5. During the planting seasons, we shall plant as many seedlings as possible.
6. We shall plan to keep our families small. We shall minimize our expenditures. We shall look after our health.
7. We shall educate our children and ensure that they can earn enough to pay for their education.
8. We shall always keep our children and the environment clean.
9. We shall build and use pit latrines.
10. We shall drink tubewell water. If it is not available, we shall boil water or use alum.
11. We shall not take any dowry in our sons' weddings, neither shall we give any dowry in our daughters' weddings. We shall keep the center free from the curse of dowry. We shall not practice child marriage.
12. We shall not inflict any injustice on anyone, neither shall we allow anyone to do so.
13. For higher income we shall collectively undertake bigger investments.
14. We shall always be ready to help each other. If anyone is in difficulty, we shall all help.
15. If we come to know of any breach of discipline in any center, we shall all go there and help restore discipline.
16. We shall introduce physical exercise in all our centers. We shall take part in all social activities collectively.

Source: Kamal Siddiqui, *An Evaluation of the Grameen Bank Operation* (Dhaka: National Institute of Local Government, 1984).

Note: Formulated in a National Workshop of 100 female center chiefs in March 1984, "Sixteen Decisions" might be called the social development constitution of Grameen Bank. All Grameen Bank members are expected to carry out these decisions.

Loan Approval and Supervision of Loan Utilization

Investment alternatives are discussed by members of a group in the weekly center meetings. When the group members and the bank worker are convinced of the viability of a potential loan, the center chief initiates the loan approval process by filling in a loan proposal form, signing it, and giving it to the bank worker, who makes a recommendation on the loan and passes it to the branch manager with the proposal form. After consulting with colleagues about a number of loan proposals and checking the viability of the loan amounts through field visits if necessary, the branch manager consolidates the individual loan proposals into a single proposal and submits it, along with the individual proposals, to the program officer in the area office. On the recommendation of the program officer, the area manager gives the final authorization necessary for releasing a loan, which is then disbursed by the bank worker in the center meeting. The whole process normally takes about one to two weeks from group discussion of an individual loan proposal to disbursement of the loan. The borrower does not have to deal with the bank staff for the loan, as would be required in other banks.

Once a loan is approved, the branch manager issues the money along with a loan passbook. The loan is given for one year and is to be repaid in 50 equal weekly installments of 2 percent of the loan amount. The 50 installments cover repayment of the principal. The interest on the loan and the contribution to the Emergency Fund are collected in the remaining two weeks of the year. The bank worker collects the weekly installment in center meetings, which take place early in the morning on a fixed day each week, and records the installment in the loan passbook of the member. The rate of interest on the loan is 16 percent a year—the same rate charged for agricultural loans by other banks in the country. The interest payment, however, comes to 8.12 percent of the loan, since the repayment is amortized over 50 weeks.

It is a regulation of the Grameen Bank that a borrower must invest the money within seven days of receipt for the purpose specified in the loan proposal. The procedure for monitoring the loan utilization starts with the group chairperson, who signs a loan utilization form and forwards it to the center chief. The center chief passes the form to the bank worker, who checks on the utilization of the loan and provides a written description of the type of investment. The bank worker sends the form, along with the description, to the branch manager, who is responsible for personally checking 50 percent of the cases at random. Once satisfied through field visits, the branch manager signs the form and forwards it to the program officer, who is the ultimate authority for supervision of loan utilization. If a loan cannot be used immediately, the borrower is advised to give the money back to the branch office and claim it when ready. In this way the borrower can avoid weekly installments and interest on the loan while it is idle.

Thus, recovery of loans is ensured by tight supervision of loan utilization by the bank staff and by mutual responsibility in the group and the center. In the event of default, there is no collateral that the bank can resort to and there is a high risk that the loan will become a bad debt. But this does not happen in practice, because a potential defaulter is singled out at the very beginning by fellow members of the group. If, because of unusual circumstances, a member fails to pay the installments, fellow members will usually contribute the money, while making it a private matter to collect from the defaulting member. Such group behavior is also facilitated by the regulation that in case of default by a member, the group will be ineligible for repeat loans.

Training and Workshops

An important factor behind the success of the Grameen Bank is its intensive field-oriented training of bank staff. Branch managers and bank workers are directly recruited, the former from recent university graduates and the latter from intermediate college graduates (12 years of schooling). The personnel at higher levels are mostly promoted from among the branch managers on the basis of performance and experience. Most officials in the area, zone, and head offices have been previously trained in, and have worked in, rural areas for a long time before taking their present positions. Thus, branch managers and bank workers are Grameen Bank's target groups for training.

One training course for branch managers lasts for about six months, of which only three weeks are spent in classroom courses at the training institute in the head office. The training begins with a two-day overview course in which the trainer introduces various banking forms that the trainee will have to master. The trainee is then sent to the field and attached to a branch office for 24 weeks, in three periods of 8 weeks. After both the first and second field visits, one week is spent in classroom courses at the training institute.

The objective of the training is to provide the trainee with (1) an understanding of the social and economic milieu and the constraints within which the Grameen Bank has to operate; (2) the capacity to identify the target clientele group, organize and motivate them, and prepare them to receive the bank's services; (3) an understanding of how to process loan applications and assist center chiefs in conducting meetings, collecting various dues, and preparing source vouchers for bank accounts; and (4) the ability to manage branch administration and accounts and to supervise loan recovery. The curriculum consists of 50 topics, including group and center organization, operation of the group and loan funds, loan-processing procedures, deposit-banking, accounts maintenance, record keeping, branch accounting, fund management, group dynamics, and maintenance of various forms, ledgers, and registers.[37]

During the first eight weeks in the field, each trainee must prepare detailed case studies of two borrowers, describing the life history of each and how their lives have changed as a result of intervention by the bank. Information about the wage rate, seasonal pattern of labor demand, terms and conditions of tenancy and the informal credit market, and prices of essential commodities for the locality is also collected. In the course of this exercise the trainee becomes acquainted with the magnitude of poverty in the area, grows to understand the process that generates it, and finds the rationale for and importance of a bank worker's task. After completion of this phase, the trainee returns to class at the training institute for a week. The class usually comprises 30 trainees drawn from 30 branches throughout all five zones. The main emphasis in the class is on discussing and questioning each other's experiences in their various fields of operation. For subsequent phases of field training, tasks are assigned to facilitate understanding of group dynamics, branch operations, and supervision and management of loan utilization and recovery. By the end of the training period, each trainee must have visited at least 15 centers and have followed up the loan utilization of two to three borrowers in each of the centers. After successful completion of training, appointments are confirmed and each new staff member is assigned to a different branch. Often new staff will have to open a branch on their own. Before departing for their new posts, new branch managers are advised by their trainers to build a branch better than the one in which they were trained.

It is apparent from the above discussion that the branch office takes substantial responsibility for training staff. Branch managers are considered responsible for producing good trainees. Part of their duty is to see that the trainees complete their assignments. If the trainees perform poorly, the branch manager is held responsible—and this is one of the factors taken into consideration for promotion of branch managers. The managers who are best able to assist and motivate the trainees are chosen for promotion as trainers. This promotion system shows the priority that the Grameen Bank attaches to the education of its personnel.

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[37] Grameen Bank, "Annual Progress Report: 1986." Grameen Bank, Dhaka, 1987 (mimeographed).

Such intensive training helps to build a dedicated cadre of bank employees. New recruits who find the Grameen Bank work difficult and not suited to their life-style leave the bank during training. Nearly a quarter of the staff drop out at this stage, but the dropout rate after final posting is insignificant.

In 1986 the training program accounted for one-fifth of the bank's operating expenses (excluding the cost of loan funds). A total of 2,118 officers and staff (7 per existing branch) were inducted for training; 26 percent dropped out, 33 percent were carried over for further training in the next course, and the remaining 41 percent were assigned final posting.

The Grameen Bank also organizes a number of workshops and exchange visits for borrowers, center chiefs, and bank staff to disseminate new ideas and experiences. In the workshops, participants discuss various problem-solving devices and approaches and build up amity and cooperation among themselves. During 1986, 334 workshops were organized and these were attended by 10,484 persons, 79 percent of whom were borrowers and center chiefs. The major responsibility for planning and implementation of workshops is carried out by the zone, area, or branch offices, according to the type of workshop.

A national workshop for women borrowers is held every two years and is attended by the managing director and the senior officers of the Grameen Bank. Fourteen women borrowers, two social development officers, and three bank workers from each zone are selected to participate in the workshop.[38] The workshop lasts for four to five days, during which experiences in various social development programs are discussed and modifications suggested. The current "Sixteen Decisions" program is an outcome of the national workshop held in 1984.

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[38] Fugelsang and Chandler, *Participation As Process,* p. 129.

5

PROGRESS OF BANK OPERATIONS

Expansion of Coverage

When the Grameen Bank began its operation as a specialized financial institution in October 1983, it had 75 branches in 5 of the 21 old districts of Bangladesh. The bank continues to operate only in those five districts but has vastly expanded its coverage. By the end of February 1987 it had 298 branches. The Bangladesh Krishi Bank, the agricultural development bank established in the early 1960s to provide agricultural credit, had 992 branches covering the entire country at the end of 1986.

The districts covered by the Grameen Bank constitute 25 percent of the area, 27 percent of the rural households, and 30 percent of the population of Bangladesh. These districts are similar to the rest of the country in population pressure, landlessness, and agricultural productivity and growth. For example, in 1983/84, the proportion of Grameen Bank target-group households was 49 percent in these districts, compared with 45 percent for Bangladesh; the proportion of cultivated area irrigated was 22 percent, compared with 20 percent for Bangladesh; and the annual growth rate of crop output during 1976-85 was 3.0 percent, compared with 2.9 percent for Bangladesh (Table 4).

The presence of the Grameen Bank is conspicuous in the five districts of its operation (see Table 5). It has covered more than 29 percent of the villages in these districts, varying from 19 percent in Dhaka to 55 percent in Patuakhali. It has organized nearly 250,000 households in 11,000 centers. In the districts of Patuakhali and Tangail, it has covered more than 25 percent of the target group (households holding less than 0.5 acre of land), and throughout all five districts, about 13 percent of the target group. This compares favorably with the estimate that only 14 percent of rural households received credit from all institutional sources during 1982 (Table 3). In the coun-

Table 4—Selected characteristics of the districts covered by the Grameen Bank

District	Population per Square Kilometer, 1981	Land Owned per Household, 1983/84	Land Operated per Farm,[a] 1983/84	Share of Landless Households,[b] 1983/84	Growth Rate of Crop Output, 1976-85	Share of Cultivated Area Irrigated, 1983/84
		(acres)	(acres)		(percent)	
Chittagong	760	0.99	1.93	58.1	2.5	37.1
Tangail	743	1.63	2.22	40.2	4.8	31.2
Dhaka	1,384	1.19	1.80	52.4	2.3	23.7
Rangpur	700	1.65	2.52	44.1	3.4	19.8
Patuakhali	463	1.98	3.36	47.1	1.8	2.1
All Grameen Bank districts	848	1.41	2.37	49.3	3.0	22.4
Bangladesh	624	1.63	2.59	44.8	2.9	19.9

Sources: Compiled from Bangladesh, Bureau of Statistics, *Final Report of Bangladesh Population Census, 1981: Analytical Findings and National Tables* (Dhaka: Government Press, 1984); Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Government Press, 1986); and Bangladesh, Bureau of Statistics, *1986 Statistical Yearbook of Bangladesh* (Dhaka: Government Press, 1986).

[a] Excludes households operating less than 0.5 acre.

[b] Includes households operating less than 0.5 acre.

Table 5—Coverage of the Grameen Bank, February 1987

District	Number of Branches Under Operation	Number of Villages Covered	Share of Villages Covered	Number of Centers Organized	Number of Members Enlisted: Male	Number of Members Enlisted: Female	Share of Target Group Households Covered[a]
			(percent)				(percent)
Chittagong	52	749	39.1	1,918	10,307	31,887	9.3
Tangail	57	1,201	48.6	2,139	16,440	29,926	27.6
Rangpur	72	1,322	24.1	2,635	16,786	45,524	11.7
Dhaka	72	1,422	18.9	2,444	12,185	41,198	8.2
Patuakhali	45	758	54.5	1,698	4,813	37,892	29.2
Bangladesh	298	5,452	6.4	10,834	60,531	186,427	4.0

Sources: Grameen Bank, *Consolidated Cumulative Statement as of February 28, 1987* (Dhaka: Grameen Bank, 1987); and Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Government Press, 1986).

[a] Estimated from the number of households operating less than 0.5 acre, reported in the 1983-84 agricultural census. It is assumed that the number of households in this category grew at 2.0 percent a year.

try as a whole, the Grameen Bank has reached more than 6 percent of the villages and 4 percent of the target-group households (Table 5).

The progress in disbursement of credit, recovery of loans, and savings in the Group Fund and Emergency Fund is seen in Table 6. By the end of 1986, Tk 1,470 million had been disbursed, of which Tk 1,169 million had already been recovered. The amount disbursed each year increased from Tk 99 million in 1983 to Tk 542 million in 1986. Over the last three years, the amount disbursed increased by an average of 33 percent a year. The disbursement is now financed largely with the revolving fund, that is, the amount recovered from the borrowers. The amount recovered from them increased from Tk 59 million in 1983 to Tk 466 million in 1986. The additional disbursement over recovery in 1986 was Tk 76 million, which is only 16 percent of the total amount recovered in that year, compared with 68 percent in 1983 and 52 percent in 1984.

Table 6—Trends in disbursement and recovery of loans and accumulation in Group Fund and Emergency Fund, 1979-86

Activities	1979-82	1983	1984	1985	1986
			(thousand persons)		
Members enlisted	30	28	63	51	63
Total members[a]	30	58	121	172	235
			(Tk million)		
Amount of credit disbursed	96.0	99.0	304.0	429.0	542.0
Amount of credit recovered	64.0	59.0	200.0	380.0	466.0
Additional disbursement over recovery	32.0	40.0	104.0	49.0	76.0
Cumulative amount disbursed[a]	96.0	195.0	499.0	928.0	1,470.0
Cumulative amount recovered[a]	64.0	123.0	323.0	703.0	1,169.0
Outstanding loans[a]	32.0	72.0	176.0	225.0	301.0
Cumulative savings in Group Fund[a]	8.1	15.9	37.9	71.4	114.5
Cumulative savings in Emergency Fund[a]	1.5	3.4	6.3	12.7	22.3

Sources: Grameen Bank, *Annual Report, 1985* (Dhaka: Grameen Bank, 1986); and Grameen Bank, *Consolidated Cumulative Statement as of December 31, 1986* (Dhaka: Grameen Bank, 1987).

[a] The figures are for the end of the calendar year.

The size of the bank's business is indicated by the total amount of outstanding loans with borrowers (the interest is charged on this amount). This total increased from Tk 72 million at the end of 1983 to Tk 301 million at the end of 1986, a rate of increase of 62 percent a year.

The amount accumulated in the Group Fund swelled from Tk 16 million at the end of 1983 to Tk 115 million by the end of 1986. The amount of savings per member was Tk 487, which is about 11 percent of the average per capita income for the country in 1985/86. In Tangail District, where most of the old branches are located, average savings per member at the end of 1986 stood at Tk 720—about 16 percent of the per capita income. By the end of 1986, the amount of savings in the Group Fund was 38 percent of the amount outstanding with the borrowers.

The Group Fund is constituted by a 5 percent compulsory deduction from each loan and a Tk 1.00 weekly contribution by each member. By the end of 1986, the Grameen Bank had disbursed a cumulative amount of Tk 1,470 million, so the compulsory (nonrefundable) deduction amounted to Tk 73.5 million. The borrowers' own savings in the Group Fund totaled 41 million, which they are entitled to withdraw when they leave the group. This part of the savings is equivalent to about 13.6 percent of the amount of outstanding loans.

The accumulation in the Emergency Fund also increased rapidly during 1983-86, from Tk 3.4 million to Tk 22 million. This fund is constituted by an additional contribution from each member of 25 percent of the interest charged on the loan, which comes to about 8 percent of the principal. Thus 2 percent of the amount recovered is deposited to the fund if the bank succeeds in collecting the interest due on the loan. By the end of 1986, Tk 1,169 million had been recovered from the borrowers, which meant that Tk 23.4 million was due to be deposited in the Emergency Fund. The accumulation in the fund was about 95 percent of this amount, and more than 7.4 percent of the loans outstanding with the borrowers, which shows the strength of the Grameen Bank in handling potential situations of bad debt.

An important characteristic of the bank is its rapidly expanding coverage of women. In Bangladesh, women generally do not participate in economic activities outside the home. A 1983/84 labor force survey estimated that only 9 percent of the labor force in Bangladesh were women.[39] But a large proportion of women, particularly in the lower-income groups, engage in various expenditure-saving activities within the household, such as food processing, kitchen gardening, goat and poultry raising, and manufacturing of various household needs (for example, quilts, rope, and nets). Women are attracted to the Grameen Bank because, with credit, they can extend the scale of such activities and turn them into income-earning activities for the household. The bank management argues that women borrowers are more careful with the capital and are more disciplined; hence the bank prefers to give credit to a female rather than a male worker in the household.[40]

Although less than 10 percent of the women in Bangladesh participate in the labor force, by as early as 1980, 39 percent of the Grameen Bank Project members were women. The coverage of women increased rapidly after the bank started operating as a specialized institution (see Table 7). By the end of 1986, about 75 percent of Grameen Bank members were women and they had 69 percent of the outstanding loans. In Patuakhali district, women were 89 percent of total members by February 1987 (Table 5).

Table 7 shows that the bank currently mobilizes mostly women members. Out of 62,751 new members enlisted during 1986,

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[39] Bangladesh, *Labor Force Survey, 1983-84.*

[40] For a detailed study of women's participation in the rural labor market, see Rushidan Islam Rahman, *The Wage Employment Market for Rural Women in Bangladesh,* Research Monograph 6 (Dhaka: Bangladesh Institute of Development Studies, 1986).

Table 7—Trends in membership and borrowing, by sex of borrower, 1983-86

Year	Members Enlisted[a]			Amount of Outstanding Loans with Members		
	Male	Female	Female as Share of Total	Male	Female	Female as Share of Total
	(thousands)		(percent)	(Tk million)		(percent)
1983	32	26	45	44	28	39
1984	53	68	56	89	88	50
1985	59	113	66	91	134	60
1986	61	174	74	92	209	69

Sources: Grameen Bank, *Annual Report*, 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986); and Grameen Bank, *Consolidated Cumulative Statement as of December 31, 1986* (Dhaka: Grameen Bank, 1987).

[a] The figures are cumulative.

61,523 (98 percent) were women. In the same year, the bank disbursed Tk 542 million, of which female borrowers received 72 percent. The total of outstanding loans with borrowers at the end of 1986 increased by Tk 76 million over the total amount at the end of 1985; the increase for female borrowers was Tk 75 million. Thus the Grameen Bank has turned into a bank for rural poor women.

Loan Portfolio

The annual reports of the Grameen Bank list more than 300 activities for which credit is extended.[41] These activities can be grouped under five broad sectors: crop farming and forestry, livestock and fisheries, processing and manufacturing, trading and shopkeeping, and transport and other services. Since 1982, credit has also been extended to groups consisting of a number of members for collective enterprises such as the purchase of shallow tubewells, power pumps, rice hullers, and oil mills and leasing of land, ponds, and markets.

The share of different sectors in total loans disbursed up to 1986 is shown in Table 8. The important point to note is that the bank basically finances noncrop agricultural and nonfarm activities. Crop cultivation and forestry accounted for only 2.2 percent of the loans disbursed in 1986, though the share of this sector has increased over time. As discussed below, most of the loans disbursed under collective enterprises are taken for crop cultivation, and a part of the loans taken for other activities is also diverted to crop cultivation. Even after accounting for these, the share of Grameen

Table 8—Trends in disbursement of loans, by sector, 1979-86

Sector	1979-83	1984	1985	1986
	(percent of total loans)			
Crop cultivation and forestry	1.5	1.6	2.2	2.2
Livestock, poultry raising, and fisheries	24.7	30.6	36.9	45.7
Processing and manufacturing	25.2	22.2	24.6	25.0
Trading and shopkeeping	39.7	32.9	28.1	23.1
Transport operations and other services	7.0	4.5	3.2	2.6
Collective enterprises	1.9	8.2	5.1	1.4

Sources: Grameen Bank, *Annual Report*, various issues (Dhaka: Grameen Bank, various years); and Grameen Bank, "Annual Progress Report, 1986," Dhaka, Grameen Bank, 1987 (mimeographed).

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[41] Grameen Bank, *Annual Report*, various issues (Dhaka: Grameen Bank, various years).

Table 9—Disbursement of loans to male borrowers, by sector, 1979-86

Sector	1979-83		1984		1985		1986	
	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans
	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)
Crop cultivation and forestry	2.32	1.8	3.06	2.0	4.48	2.7	4.55	3.0
Livestock, poultry raising, and fisheries	19.76	15.4	25.32	16.6	33.09	20.0	32.70	21.8
Processing and manufacturing	21.39	16.7	19.35	12.7	21.46	13.0	20.59	13.8
Trading and shopkeeping	67.95	52.9	76.15	50.1	82.85	50.1	77.64	51.9
Transport operations and other services	13.49	10.5	12.63	8.3	11.85	7.2	11.29	7.5
Collective enterprises	3.49	2.7	15.63	10.3	11.75	7.1	2.94	2.0
All sectors	128.40	100.0	152.14	100.0	165.48	100.0[a]	149.71	100.0

Sources: Grameen Bank, *Annual Report*, 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).

[a] Parts do not add to total because of rounding.

Bank loans for crop cultivation has never been more than 6 percent.

In the initial years, trading and shopkeeping received the largest proportion of loans. With the expansion of the bank, however, the share of this sector has been reduced drastically—from about 40 percent during 1979-83 to 23 percent in 1986. The absolute amount of loans issued for trading and shopkeeping increased only marginally from Tk 120 million in 1985 to Tk 125 million in 1986, while total disbursement increased from Tk 429 million to Tk 542 million. The share of the livestock and fisheries sector increased rapidly from 25 percent during 1979-83 to 46 percent in 1986. The change is, however, mainly due to the expanding coverage of women, as women take a much smaller proportion of loans for trading and shopkeeping than do men. In 1986, 71 percent of the loans were issued for livestock raising and for rural processing and manufacturing activities.

The purpose for which the loan is taken differs significantly according to the sex of the borrower. Nearly half of the loans issued to men are disbursed for trading and shopkeeping activities, while a similar proportion of loans to female members is disbursed for livestock and poultry raising (see Tables 9 and 10). The share of different sectors in total loans disbursed to men and women has remained relatively stable over the years, except that the share for livestock has increased marginally at the expense of the processing and manufacturing sector. For all members, however, there has been a significant change in the sectoral shares of loans for livestock and fisheries at the expense of trading, and transport and other services (Table 8) because of the rapidly expanding coverage of female members. Women are little involved in trading and transport operations because those jobs have to be done outside the home. When women take loans for trading, they usually engage in shopkeeping within the household. Since the Grameen Bank is now concentrating its efforts on organizing poor women, nearly four-fifths of total loans in the future may go to the livestock and manufacturing sectors.

Individual activities that received more than 1 percent of the loans during 1983-85 are listed separately for male and female borrowers in Tables 11 and 12, respectively.

Table 10—Disbursement of loans to female borrowers, by sector, 1979-86

Sector	1979-83		1984		1985		1986	
	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans
	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)
Crop cultivation and forestry	0.63	1.0	1.90	1.2	4.87	1.9	7.35	1.9
Livestock, poultry raising, and fisheries	28.47	42.8	67.77	44.5	124.80	47.5	215.07	54.9
Processing and manufacturing	27.81	41.8	48.10	31.6	83.90	31.9	114.88	29.3
Trading and shopkeeping	9.39	14.1	23.94	15.7	37.41	14.2	47.22	12.0
Transport operations and other services	0.07	0.1	1.19	0.8	1.96	0.7	2.95	0.8
Collective enterprises	0.15	0.2	9.32	6.1	10.03	3.8	4.55	1.2
All sectors	66.52	100.0	152.22	100.0[a]	262.97	100.0	392.02	100.0[a]

Sources: Grameen Bank, *Annual Report,* 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
[a] Parts do not add to total because of rounding.

The activities pursued by male members are diverse, particularly in the trading and processing sectors. The 20 major activities listed in Table 11 accounted for about 84 percent of the loans disbursed in 1985. The share of these 20 activities in total loans increased rapidly during 1983-85, indicating a gradual concentration of loans in the traditional activities. Four activities—cattle fattening, seasonal crop trading, milch cow raising, and paddy and rice trading—accounted for 39 percent of total loans issued in 1985, an increase from 29 percent in 1983.

The activities pursued with the Grameen Bank credit are less diverse for the female borrowers. The 14 activities listed in Table 12 accounted for 91 percent of total loans disbursed up to the end of 1985, but 3 activities—milch cow raising, paddy husking, and cattle fattening—accounted for 70 percent of total loans. Women also took a significant proportion of loans for traditional cottage industries such as handloom weaving, cane and bamboo works, mat making, fishing-net making, and tailoring.

In the initial years, the majority of loans issued by the Grameen Bank were for trading activities. This concentration attracted criticism from various circles. It was argued that excessive credit for this sector would be inflationary, since the circulation of the additional money would not be counterbalanced by an increase in production activity. Also, the larger volume of credit for trading, unless associated with a concomitant increase in production, would keep the volume of trade unchanged and would merely redistribute employment and income from nonmembers to members. It has been noted that the share of the trading sector in Grameen Bank loans had declined over time, but it still accounted for about 23 percent of total loans disbursed in 1986 (Table 8). In order to answer the criticism, some justifications for the trading sector loans are in order.

To examine the linkage of trade with the rural economy, trading activities were classified into a number of subsectors according to the origin of the commodity traded, and an estimate was made of the share of each subsector in total loans disbursed for trading and shopkeeping during 1980-85 (see Table 13). Trading was found to have a strong linkage with rural production activities such as crops, livestock, and fisheries,

Table 11—Major activities for which male borrowers took loans, 1983-85

Sector/Activity	Share of Total Loans Disbursed 1983	1984	1985
	(percent)		
Trading and shopkeeping			
Seasonal crop trading	5.1	8.5	10.5
Paddy and rice trading	9.0	10.3	8.4
Grocery and stationery shop	5.7	5.6	6.6
Cattle and goat trading	3.2	4.9	4.6
Handloom products trading	2.6	1.8	2.9
Cloth trading	1.7	1.8	2.9
Fish trading	2.2	2.1	2.3
Wood and timber trading	1.7	1.6	1.9
Peddling	2.1	1.7	1.9
Vegetable trading	1.2	1.6	1.5
Betel leaf and betel nut trading	0.8	1.0	1.4
Flour trading	1.7	1.7	1.2
Mustard seed trading	1.3	1.2	1.0
Gur (raw sugar) trading	1.1	1.2	0.9
Livestock and fisheries			
Cattle fattening	8.5	10.0	11.4
Milch cow raising	6.4	7.4	8.9
Processing and manufacturing			
Paddy husking	4.4	3.9	4.3
Handloom weaving	3.2	2.9	2.9
Transport and services			
Rickshaw pulling	5.8	5.9	5.3
Farming			
Crop cultivation	1.4	2.2	2.9
All major activities	69.1	77.3	83.7

Sources: Compiled from Grameen Bank, *Annual Report*, 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

the trading of which received about 57 percent of trading sector loans. Trading of cottage industry products located in rural areas received another 8 percent of the loans. Among the major crops traded are paddy and seasonal agricultural produce such as pulses, oilseeds, and vegetables. Since these commodities face large seasonal fluctuations in price, some of the Grameen Bank loans may in fact be used for seasonal storage to take advantage of higher prices later. Widespread small-scale storage may have positive income distribution effects and may also improve the working of the rural commodity markets by reducing price fluctuations.

It should also be recognized that widespread petty trading may not necessarily replace large-scale trading in the organized sector. A major constraint for large-scale traders to move into interior areas is the high unit cost of transport due to underdeveloped infrastructure facilities.[42] The advantage of the petty traders is that the small amounts they trade can be carried as headloads. The environment of underdeveloped trading and transport sectors induces rural households in interior areas to engage more in subsistence-oriented production. Provision of credit for petty trading may thus induce production for the market and in-

Table 12—Major activities for which female borrowers took loans, 1983-85

Sector/Activity	Share of Total Loans Disbursed 1983	1984	1985
	(percent)		
Trading and shopkeeping			
Paddy and rice trading	3.7	3.7	3.7
Grocery and stationery shops	4.3	4.0	3.7
Peddling	0.7	1.1	1.2
Flour trading	1.8	1.5	1.2
Livestock and fisheries			
Milch cow raising	29.1	33.1	36.3
Cattle fattening	11.0	12.3	10.9
Goat and poultry raising	2.9	1.9	2.0
Processing and manufacturing			
Paddy husking	23.3	25.0	22.6
Cane and bamboo works	3.1	2.0	2.5
Handloom weaving	3.5	1.8	1.8
Mat making	1.4	1.6	1.8
Cheera and muri (rice products)	2.3	1.9	1.3
Tailoring	1.8	1.2	1.2
Fishing-net making	0.8	1.2	1.0
All major activities	89.7	92.3	91.2

Sources: Compiled from Grameen Bank, *Annual Report*, 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

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[42] The unit cost of transport for bullock carts that operate on dirt roads in interior areas is about seven times higher than the cost for trucks that operate on paved roads. The average unit cost of transport for all traffic is estimated at 2.3 times higher on a dirt road than on a paved road in the same locality. See Omar H. Chowdhury and Mahabub Hossain, "Roads and Development: A Case Study of Return on Investment in Rural Roads in Bangladesh," Bangladesh Unnayan Parishad, Dhaka, December 1985 (mimeographed).

Table 13—Distribution of trading sector loans, by origin of commodities, 1979-85

Sectoral Origin of Commodities	1979-83 Amount of Loans	1979-83 Share of Loans	1984 Amount of Loans	1984 Share of Loans	1985 Amount of Loans	1985 Share of Loans
	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)
Crop cultivation	28,590	37.0	46,392	46.4	54,886	45.6
Livestock, poultry raising, and fisheries	12,479	16.1	13,240	13.3	13,514	11.2
Forestry	2,519	3.3	3,130	3.1	3,865	3.2
Agricultural inputs	886	1.1	567	0.6	612	0.5
Rural industry	8,712	11.3	10,284	10.3	9,770	8.1
Urban industry	9,524	12.3	7,347	7.3	11,399	9.5
Trading	62,710	81.1	80,960	80.9	94,046	78.2
Peddling	3,553	4.6	3,863	3.9	5,886	4.9
Shopkeeping	11,087	14.3	15,260	15.2	20,365	16.9
Total	77,350	100.0	100,083	100.0	120,297	100.0

Sources: Constructed from Grameen Bank, *Annual Report,* 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

crease the volume of trade. Petty traders would operate in interior areas and carry goods to secondary markets well connected by roads, rail, or waterways, from where the business would be taken over by large traders. In this sense, provision of credit for petty trading can facilitate the development of markets and thereby increase the volume of both local production and trade.

Of course, the demand for trade services will increase over time because of the linkage effects of agricultural growth and rapid movement of rural population to urban areas (discussed in Chapter 3 in the context of the role of institutional credit in alleviation of poverty). Gradual diffusion of new technology in agriculture increases the labor productivity and household income of farmers and provides effective demand for a range of goods and services that are most effectively produced in rural areas by small-scale producers.[43] Grameen Bank loans for livestock raising and for processing and manufacturing activities are in fact supporting such activities. But the diffusion of technology also increases the demand for trading services to permit greater movement of both farm and nonfarm goods from producers to consumers. In order to allow the relatively poor people to gain from the dynamic process of development, access to working capital for trading is necessary. The bank's effort to provide the poor with access to credit for trading activities is thus highly desirable.

Collective Enterprises

In 1982 the Grameen Bank started providing large loans to a cooperative body consisting of a number of groups or centers for the joint undertaking of collective enterprises. A loan to an individual is limited to a maximum of Tk 5,000, but loans for collective enterprises are usually from Tk 50,000 to Tk 100,000. In a few cases, loans up to Tk 500,000 have been approved. The bank considers loans for collective enterprises to be one of its major areas of expansion for the benefit of the poor and for reducing the costs of operation.[44] The main objectives of these loans are to enable members to reap economies of scale in their activities, to

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[43] John W. Mellor and Uma Lele, "Growth Linkages of the New Foodgrain Production Technologies," *Indian Journal of Agricultural Economics* 28 (January-March 1973): 35-55; and John W. Mellor, "Agriculture on the Road to Industrialization," in *Development Strategies Reconsidered,* ed. John P. Lewis and Valeriana Kallab (New Brunswick, N.J.: Transaction Books, 1986), pp. 67-89.

[44] Muhammad Yunus, *The First Decade of Grameen Bank, 1976-86* (in Bengali) (Dhaka: Grameen Bank, 1987).

Table 14—Loans disbursed for various types of collective enterprises, 1982-85

Type of Enterprise	1982-84		1985		1985 Loans as Share of Those in 1982-84
	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	
	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)	
Improved technology	5,127	17.9	1,283	5.9	25.1
Leasing of markets and ferry crossings	3,495	12.2	1,323	6.1	37.9
Trading and storage	4,300	15.0	1,275	5.9	29.7
Joint farming	13,304	46.6	16,170	74.2	121.5
Livestock and fisheries	1,674	5.9	1,475	6.8	88.1
Transport operations and other services	680	2.4	255	1.2	37.5
Total	28,580	100.0	21,781	100.0[a]	76.2

Sources: Grameen Bank, *Annual Report*, 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

[a] Parts do not add to total because of rounding.

compete with the upper-income group in activities that require large amounts of capital, and to increase labor productivity by adopting improved technology. Examples of such activities are investment in irrigation equipment; installation of rice, oil, and weaving mills; leasing of markets, orchards, waterbodies, and ferry crossings; and leasing of agricultural land. Loans are granted to groups and centers that have demonstrated that they are well managed, have observed the bank's rules and regulations meticulously, and have accumulated a substantial fund in a collective special savings account. Such a loan is issued to the collective body, but each member is responsible for an equal proportion of the loan and for making repayment in weekly installments of 2 percent of the loan amount, just as in the case of loans to individuals.

Collective enterprises are managed by three committees: one for management, one for audit, and one for finance.[45] On a consensual basis, the members select three representatives for each committee. The group chairperson or the center chief acts as the convener of committee meetings. The committee supervises daily operations and reviews the economic situation in weekly meetings.

The loans for collective enterprises quickly became popular, but because of widespread failure of these enterprises, the enthusiasm of the members could not be sustained. In 1984, 32 percent of Grameen Bank members participated in collective enterprises; in 1985 that rate was reduced to 17 percent. The share of collective enterprises in total loans jumped from 1.9 percent in 1983 to 8.2 percent in 1984, but fell to 5.1 percent in 1985 and further to 1.4 percent in 1986 (Table 8).

Table 14 shows the importance of various types of activities for which loans were disbursed for collective enterprises. Between 1982 and 1984, nearly one-half of the total loan amount was taken for joint crop cultivation or pisciculture. The amount disbursed for crop cultivation through 1984 was Tk 13 million, which compares favorably with Tk 8 million issued for these purposes as individual loans. The insignificant demand for crop loans by individual bank members is due to the small amount of land owned by members and to the requirement that loans be repaid in weekly installments even though the income from crop cultivation is seasonal. Provision of a larger amount of credit for undertaking collective enterprises induces members to rent land and organize production on a cooperative basis, since they can pay the weekly installments from their regular income from nonfarm enterprises undertaken with individual loans. Thus, in collective enterprises, the Grameen Bank found an avenue of financing crop cultivation and engaging the rural poor in this important production activity. In 1985, crop cultivation accounted for about three-fourths of the loans disbursed for collective enterprises.

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[45] Fugelsang and Chandler, *Participation As Process*, p. 154.

The failure of collective enterprises to expand as fast as individual enterprises is mainly due to a slack demand for such loans to undertake nonfarm activities or to finance investment in improved technology. Thus the basic purposes of introducing collective enterprise loans (reaping economies of scale and increasing labor productivity) seem to have been defeated.

According to Grameen Bank management, about one-fifth of the collective enterprises undertaken in the initial years failed. The bank attributes these failures to the difficulties of organizing groups with a large number of members, problems in maintaining accounts, distrust among members, unfamiliarity with new techniques, improper planning about the need for working capital to more fully utilize machines, and interference with the rural power structure. In many cases, undertaking collective enterprises led to misunderstanding among members in the centers, and in a few cases the center chief tried to control the money for personal benefit.

An important factor behind the slack demand for credit for acquisition of improved technology may be that the same loan repayment procedures are required for collective loans as for individual loans. Acquisition of machinery and fixed assets is a relatively long-term investment with a long payback period. Grameen Bank credit, on the other hand, has to be fully repaid within one year—a term that is more suitable for financing working capital needs. Some of these investments, such as installation of irrigation equipment, do not generate a regular flow of income, so it is difficult to meet the bank requirement that loans be repaid in weekly installments. The enthusiasm for taking collective enterprise loans for crop cultivation may also die down very soon unless loan repayments are changed from weekly to seasonal installments so that members can repay the loans after harvest.

In 1986 the bank decided that its Technology Division would take up direct management of the collective enterprises.[46] That division is to guide the enterprises to a profit-making position while imparting management and technical training to bank members. For the present, the bank holds a one-fourth ownership in these enterprises. When members become capable enough, the ownership and management of the enterprises will be handed over to them in stages.

Under this arrangement the bank has already taken up the management of the ailing collective enterprises and has purchased the abandoned agricultural machinery, such as power tillers and irrigation equipment. For repair and maintenance of the machinery and equipment, two service centers have been established. The bank has also moved into large-scale fisheries projects by leasing government-owned water bodies on behalf of the landless. In January 1986 the government handed over to the Grameen Bank the management of one such large-scale fisheries project that covers 783 ponds with 1,030 acres of water bodies in a 200-square-mile site. The bank has also leased 300 acres of mangrove land for 10 years from the Ministry of Fisheries and Livestock and plans to develop the area into an ideal shrimp farm, train the landless in shrimp farming, and ultimately hand the farm over to them.

Use of Group Fund

The Group Fund was created to provide loans to members at times of emergency, such as illness or social ceremony, so that

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[46] Grameen Bank, "Annual Progress Report: 1986."

Table 15—Utilization of the Group Fund, 1983-86

Variable	Unit	1983	1984	1985	1986
Contributions during the year	Tk million	16.0	21.9	33.5	43.1
Cumulative savings by the end of the year	Tk million	16.0	37.9	71.4	114.5
Number of loans	Thousand	14.9	12.9	18.5	n.a.
Share of members taking loans	Percent	n.a.	10.7	10.8	n.a.
Amount of loans taken during the year	Tk million	2.6	6.5	11.0	17.3
Cumulative amount of loans taken by the end of the year	Tk million	4.8	11.3	22.3	39.5
Loans disbursed from Group Fund as a share of cumulative savings	Percent	16.3	17.2	15.4	15.0
Unutilized balance in Group Fund[a]	Tk million	13.4	31.4	60.4	97.3
Unutilized balance as a share of outstanding normal loans	Percent	18.7	17.8	26.8	32.3

Sources: Compiled from Grameen Bank, *Annual Report,* various issues (Dhaka: Grameen Bank, various years); and Grameen Bank, *Consolidated Cumulative Statement as of December 31, 1986* (Dhaka: Grameen Bank, 1987).

Note: n.a. means not available.

[a] This is an imprecise figure. It should have been calculated by deducting the amount of outstanding loans from the amount accumulated in the Group Fund, but the figure for the amount of outstanding loans from the Group Fund is not available. Instead, the amount of the loans issued during the year has been deducted from the accumulated amount.

a borrower does not have to touch capital or resort to local moneylenders (see Chapter 4). The fund is operated by members of the group, who also decide the terms and conditions of the loan. So far, loans have been disbursed from the fund free of interest.

The pattern of utilization of the Group Fund is shown in Table 15. Only 11 percent of members took loans from the fund during each of the two years for which figures are available, and the amount of the loans disbursed varied from 15 to 17 percent of the amount accumulated in the fund. Thus the Group Fund has become an important source of funds for normal operation of the bank. In December 1983 the unused balance in the fund constituted about 19 percent of the amount of outstanding normal loans with borrowers; it rapidly increased to about 32 percent by the end of 1986.

It is difficult to understand why a large proportion of the Group Fund remains unused, since experience indicates that the poor tend to be in constant need of credit (Table 3). One reason may be that the unutilized amount earns an annual rate of interest of 8.5 percent from the Grameen Bank, but if it is lent to members it earns no interest, so the group is reluctant to lend from the fund unless a member is in dire need. But the same restraint could be achieved by imposing interest on the loans. It may be that the group does not want to profit from emergencies of fellow members. Also, since individual members do not have any claim on the amount accumulated in the fund, the profit motive may not operate.

The purposes for which loans have been issued to members from the Group Fund are seen in Table 16. Social and household needs account for nearly one-third of total loans, and health and medical expenses constitute another one-sixth. The share of the loans for these unproductive purposes increased from 45 percent in the 1979-83 period to 51 percent in 1985. Loans are occasionally taken from the Group Fund for the repayment of overdue loans from other sources, but most of the money is used to repay Grameen Bank loans. Presumably, when a member finds it hard to pay the weekly installments because of some genuine problems, the members allow him to take a loan from the fund to alleviate the difficulties and maintain the discipline of the Grameen Bank. However, the share of such loans is very small and declined from 8.0 percent during 1979-83 to only 2.6 percent in 1985.

An important point to note from Table

Table 16—Distribution of Group Fund loans, by purpose for which loans were taken, 1979-85

	1979-83		1984		1985	
Purpose	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans
	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)
Unproductive	2,171	45.2	2,955	45.3	5,606	51.1
Social and household needs	1,166	24.3	1,840	28.2	3,460	31.5
Health and medical expenses	620	12.9	682	10.5	1,857	16.9
Repayment of old loans	385	8.0	433	6.6	289	2.6
Productive	2,635	54.8	3,564	54.7	5,366	48.9
Crop cultivation	694	14.4	1,041	16.0	1,598	14.6
Purchase of raw materials for manufacturing	356	7.4	260	4.0	374	3.4
Repair and maintenance of equipment	416	8.7	442	6.8	497	4.5
Acquisition of fixed capital	188	3.9	329	5.0	785	7.2
Trading capital	941	19.6	860	13.2	1,022	9.3
Collective enterprises	40	0.8	632	9.7	1,091	9.9
Total	4,806	100.0	6,519	100.0	10,972[a]	100.0[a]

Sources: Grameen Bank, *Annual Report*, 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

[a] Parts do not add to total because of rounding.

16 is that nearly half of the Group Fund loans were issued for purposes for which members are eligible to take normal loans from the Grameen Bank, so Group Fund loans have not been limited to emergency situations. Since individual loans from the bank have a maximum limit (Tk 5,000), members capable of productively utilizing a larger amount of capital may borrow the additional money from the fund. The members also see the advantages of interest-free loans with flexible repayment procedures. That this kind of borrowing is not more widespread gives the impression that a few influential members may take advantage of the fund for personal benefit.

6

PERFORMANCE IN CREDIT OPERATIONS

Reaching the Target Group

The main objective of the Grameen Bank is to "extend credit facilities to poor men and women for creating opportunities for self-employment for the vast unutilized and underutilized manpower resources."[47] Thus the Grameen Bank is a credit program targeted to the poor for improvement of their economic condition. It is generally recognized that under existing socioeconomic conditions, it is difficult to reach the poor with resources for development. The general experience of developing countries is that the poor have gained very little from the expanding supply of agricultural credit, which is provided at a rate of interest much below the opportunity cost of capital. In recent literature it has been argued that the low rate of interest generates excess demand for capital from which the rich gain proportionately more because of their connections with local officials and their capacity to apply political pressure.[48]

The Grameen Bank target group is defined as persons belonging to households that own less than 0.5 acre of cultivable land. Table 17 shows the distribution of sample borrowers according to the amount of cultivated land owned, as reported by them to research investigators during a 1985 field survey of 975 randomly selected borrowers from all districts under Grameen Bank operation. Only 4.2 percent of the borrowers belonged to nontarget-group households. In a 1982 survey of 611 borrowers, the proportion of nontarget-group

Table 17—Distribution of borrowers, by amount of cultivated land owned, 1985

Amount of Cultivated Land Owned	Male Borrowers		Female Borrowers		All Borrowers	
	Number	Percent	Number	Percent	Number	Percent
(acres)						
None	264	59.9	379	71.0	643	66.0
Less than 0.10	43	9.8	31	5.8	74	7.6
0.10–0.49	111	25.2	106	19.9	217	22.3
0.50–0.99	18	4.1	15	2.8	33	3.4
1.00–2.49	5	1.1	2	0.4	7	0.7
2.50 or more	0	0.0	1	0.2	1	0.1
Total	441	100.0[a]	534	100.0[a]	975	100.0[a]

Source: Survey of 975 borrowers.

[a] Parts do not add to total because of rounding.

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[47] Yunus, "Experiences in Organising Grass Root Initiatives," p. 9.

[48] Dale W Adams and Douglas H. Graham, "A Critique of Traditional Agricultural Credit Projects and Policies," *Journal of Development Economics* 8 (June 1981): 347-366; and Dale W Adams and Robert C. Vogel, "Rural Financial Markets in Low-Income Countries: Recent Controversies and Lessons," *World Development* 14 (April 1986): 477-487.

Table 18—Distribution pattern of landownership and landholding, 1985

Amount of Land Owned and Operated	Landownership			Land Operation		
	Male	Female	All	Male	Female	All
(acres)	(percent of total borrowers in sample)					
None	6.6	11.4	9.2	42.0	56.7	50.0
Less than 0.10	36.7	44.6	41.0	7.5	5.4	6.4
0.10–0.49	45.1	33.7	38.9	24.5	19.9	21.9
0.50–0.99	7.9	6.7	7.3	15.2	10.5	12.6
1.00–2.49	3.4	2.8	3.1	9.8	6.7	8.1
2.50 or more	0.3	0.8	0.5	1.1	0.5	0.9
	(acres)					
Average	0.23	0.22	0.23	0.38	0.28	0.32

Source: Survey of 975 borrowers.

households was 5.6 percent.[49] Thus, even after the rapid expansion of the bank's coverage, not only has the membership remained confined mostly to the target group, but there has in fact been an improvement in this respect. Indeed, most Grameen Bank members are extremely land-poor. The 1982 survey found that two-thirds of them did not own any cultivated land. The 1985 survey sustained this result.

It could be argued that ownership of cultivated land is not the proper criterion for identifying the poor. A borrower may have noncultivable land, such as fish ponds, orchards, or homestead, and can also rent land that could provide a good source of income. The pattern of distribution of landownership and landholding reported in Table 18 shows that total land owned or operated is also very insignificant for most of the borrowers. The average amount of land owned in 1985 was only 0.23 acre, and the average amount of land operated was 0.32 acre. Members who owned more than 1.0 acre of land were only 3.6 percent of the sample—down from 5.2 percent in the 1982 survey. Members who operated more than 1.0 acre (by renting land) were only 9.0 percent of the sample, compared with 10.4 percent in 1982.

There are several factors behind the success of Grameen Bank in reaching its target group. Perhaps the most important one is the selection of the extreme poor as the bank's target. Although accurate information about the landownership status of a household can be concealed, the target group is so poor that its members can be easily identified by such characteristics as their appearance and clothing.

Second, the formation of groups and their compulsory weekly meetings have helped the bank to keep out of its domain the economically better off. The relatively affluent would feel ashamed to mix with the extreme poor on a regular basis.

Third, crop production is usually the major source of income for households that own more than 0.5 acre of cultivated land, and this generates income for the household only after the crop is harvested. With the seasonal flow of agricultural income, it is difficult to maintain repayment of a loan in weekly installments as required by the bank. This seasonal income also checks the tendency on the part of the nontarget group, whose main occupation is farming, to apply for Grameen Bank loans, which they would take mainly for the purpose of crop cultivation.

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[49] Hossain, *Credit for the Rural Poor*, pp. 57-63.

Finally, although the bank charges the same nominal rate of interest as the other specialized credit institutions (16 percent a year), the effective cost of the loan to the borrower is higher. Each bank member has to deposit 5 percent of the loan in the Group Fund (this deposit is 10 percent of the average amount outstanding for the year and cannot be reclaimed by the member) and 25 percent of the interest charges in the Emergency Fund. Although the contributions to the Group Fund and Emergency Fund cannot be treated as income by the bank, the effective cost of a loan to the borrower comes to about 33 percent[50] compared with the 16 percent rate of interest charged by other banks. The higher cost of credit also keeps the economically better off away from the Grameen Bank.

One issue to be considered is whether the high implicit rate of interest might constrain the expansion of credit from the Grameen Bank, since this rate cuts down the number of activities that can be profitably undertaken with a bank loan. To address this issue, it is necessary to estimate the rate of return on investment for various activities that are undertaken with the loans. This is, however, an extremely difficult task because of the problems involved in estimating the amount of labor used in informal activities. These activities provide mostly self-employment to workers engaged in multiple occupations. Also, different household members engage in a number of activities, mutually helping each other in their tasks. Collection of accurate information on labor allocated to different activities would require a survey on time allocation for each member of the household.

An additional problem is that widespread underemployment makes the task of estimating the cost of family labor difficult. The 1982 study mentioned above attempted to estimate the rate of return on investment on the basis of a number of assumptions that are of questionable validity.[51] The rate of return on investment was calculated by imputing the cost of family labor as equal to the agricultural wage rate at 86 percent for livestock and poultry raising, 61 percent for trading, and minus 38 percent for processing and manufacturing activities. In the manufacturing group, only weaving, pottery, and dairy products had a positive rate of return.

Even at a negative rate of return, loans are taken for processing and manufacturing enterprises because they enable employment of a household's female labor, which has low opportunity cost. When family labor was imputed at the market wage, the rate of return on investment was estimated by the 1982 study at 57 percent for male-borrower households and minus 87 percent for female-borrower households. But when family labor was imputed at a cost of 80 percent of the market wage rate, the rate of return on investment for female-borrower households was 27 percent. In the rural labor market, however, women receive only 30-40 percent of the wage paid to male workers.[52] If labor were imputed at an opportunity cost of 60 percent of the wage rate, the rate of return on investment would increase to 145 percent.

These calculations show the high sensitivity of the estimate of the rate of return on investment to assumptions about the opportunity cost of labor. Thus, as long as family labor remains underutilized and has low opportunity cost, the Grameen Bank's loans at the implicit high rate of interest will remain attractive to the poor. When the labor market becomes tight, and prospective borrowers can utilize all their available labor at a market wage higher than the return on family labor in bank-financed enterprises,

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[50] On a loan of Tk 100, the borrower would have to pay Tk 8 in interest (at 16 percent on an average balance of Tk 50) plus Tk 2 as a contribution to the Emergency Fund. Thus the principal and the interest amount to Tk 110. The borrower would receive initially only Tk 95, as Tk 5 is deducted for the Group Fund. Thus the borrower would pay Tk 15 in addition to the amount of Tk 95 received. The average balance in hand would be Tk 45 (Tk 95 minus Tk 50 paid in the first 25 weeks). Therefore, the implicit annual rate of interest is 33.3 percent (15 divided by 45).

[51] Hossain, *Credit for the Rural Poor,* pp. 77-94.

[52] R. I. Rahman, *The Wage Employment Market,* pp. 53-57; and Hossain, "Employment and Labour," p. 15.

Table 19—Occupation of members and heads of household as stated on membership application form

Occupation	Members		Heads of Household	
	Principal Occupation	Principal Plus Secondary Occupation	Principal Occupation	Principal Plus Secondary Occupation
		(percent of members)		
None, or not stated	41.6	41.6	5.4	5.4
Crop cultivation	7.3	17.3	15.3	28.0
Agricultural labor	8.4	10.1	22.3	26.3
Livestock, poultry raising, and fisheries	0.1	0.7	0.6	1.1
Industry	15.1	25.4	14.0	19.4
Trading and shopkeeping	19.2	26.2	25.3	34.6
Transport and construction	2.8	3.6	5.0	6.1
Other services	5.4	7.4	12.1	14.1
Total	100.0[a]	132.1[a,b]	100.0	135.0[b]

Source: Unpublished data contained in approximately 4,700 Grameen Bank membership application forms.

Note: The head of household is not necessarily a member of the Grameen Bank. Most of the male members are heads of household, but for most female members the head is a different person.

[a] Parts do not add to total because of rounding.

[b] These figures show the index of multiple occupations, indicating that 35 percent of the household heads and 32 percent of the Grameen Bank members had more than one occupation.

the demand for Grameen Bank loans will slacken. Since the higher-income group has better job opportunities and higher value for leisure, such high-cost loans are less attractive to them than to the poor.

Coverage of Occupational Groups

Table 19 provides information about the occupational backgrounds of Grameen Bank members and those of heads of households to which members belonged at the time of application for bank membership. This information was obtained by processing approximately 4,700 loan application forms kept at Grameen Bank offices for the branches selected for this study. About 42 percent of the members had no income-earning occupation (though some may have been unpaid family workers in household enterprises) at the time of application for the first loan. Thus the loans helped to generate new jobs for a large proportion of the members. Only 5 percent of the heads of borrower households, however, reported having no employment at the time of joining the bank. This discrepancy occurs because most household heads are male and must do something to make a living. But the majority of Grameen Bank members are women, a large proportion of whom are dependents in the household. A Grameen Bank loan enables them to participate in productive activities and lowers the dependency ratio in the family.

Among those applicants who were employed, the majority (59.0 percent) were involved in industry and trading, and very few (14.4 percent) had agricultural labor as their principal occupation. Cultivating family farms and working as agricultural wage laborers were the principal occupations of 15 and 22 percent of the heads of households, respectively. According to the 1983-84 agricultural census, about two-thirds of the Grameen Bank target group were agricultural-labor households.[53] This compari-

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[53] In 1983/84 there were an estimated 13.8 million rural households, of which 6.2 million belonged to the Grameen Bank target group. The number of agricultural-labor households was estimated at 5.5 million, of which 3.78 million belonged to the Grameen Bank target group. See Bangladesh, *Census of Agriculture and Livestock,* p. 81.

Table 20—Average size of current loans, by length of bank membership, 1985

Number of Loans Taken	Number of Borrowers	Share of Borrowers	Average Size of Loan
		(percent)	(Tk)
One	276	28.3	2,181
Two	378	38.8	3,205
Three	171	17.5	3,702
Four	91	9.3	3,324
Five or more	59	6.1	3,644
Total	975	100.0	3,040

Source: Survey of 975 borrowers.

son indicates that households engaged in trading and manufacturing have been reached relatively more than those occupied in agricultural wage labor. Since agricultural wage laborers are the poorest among the poor, it appears that the Grameen Bank has had limited success in serving the extreme poor within the landless group.

An important factor behind the limited success of the bank in reaching agricultural wage laborers, compared with other occupational groups, could be the Grameen Bank emphasis on investment in activities that generate regular income. Wage laborers are timid about coming forward when a new branch is being established because they are used to working for others and are fearful of venturing into activities that need some entrepreneurial skills. They would like to join the bank later, when they have gathered sufficient courage by observing the experience of others, but by that time it is difficult to enter a group. Membership in a group is permanent unless a member leaves voluntarily. A Grameen Bank branch has a fixed number of workers and a bank worker has the capacity to serve 200-250 members. Once the capacity of the branch is reached, it becomes difficult for a person to join the bank. The Grameen Bank could address this problem by considering a policy of graduating older members in order to extend bank coverage to less entrepreneurial, poorer households who would like to join later.

However, the Grameen Bank may indirectly contribute to increases in the income of those agricultural wage laborers who are left out. Members who use their loans to pursue nonfarm activities withdraw from the agricultural labor market, thus reducing the supply of agricultural workers. This increases the number of days of agricultural employment available for the remaining workers and puts an upward pressure on the wage rate, thereby increasing total wage earnings for nonparticipants within the bank's target group.

Size of Loans

The average size of current loans received by sample borrowers in the 1985 survey was estimated at Tk 3,040—Tk 3,279 for men and Tk 2,843 for women. On average, female borrowers thus received about 13 percent less than male borrowers. The Grameen Bank has set Tk 5,000 as the maximum amount that can be approved for an individual loan. The survey found that about 14 percent of current loans were Tk 4,000 or more, and about 12 percent were Tk 1,500 or less. Nearly 50 percent of the loans to male members were between Tk 2,500 and Tk 4,000, while about 40 percent of loans to female members were in this range.

In general, new members received smaller loans than old members. Members who had already taken five or more loans composed about 6 percent of the sample and they received, on average, about two-thirds more than those who were first-time borrowers (see Table 20). The marginal increase in the size of the loan, however, declines sharply with the length of membership. Second-time borrowers received an average of about Tk 1,024 more than first-time borrowers, but the increase for third-time borrowers was only about Tk 500. Beyond the third loan, the average loan amount was in fact smaller than that for third-time borrowers.

This phenomenon can be explained as follows. With every repeat loan, the amount of equity in the capital of the enterprise

Table 21—Loan distribution, by purpose of loan and sex of borrower, 1985

Purpose of loan	Male Borrowers	Female Borrowers	All Borrowers
		(percent of current loan amount)	
Crop cultivation	4.0	4.6	4.3
Livestock, poultry raising, and fisheries	18.5	44.6	31.9
Processing and manufacturing	18.6	29.9	24.4
Trading and shopkeeping	49.7	18.7	33.8
Transport and other services	9.2	2.2	5.6
Total	100.0	100.0	100.0

Source: Survey of 975 borrowers.

increases, but the rate of return on capital declines because of the higher opportunity of family labor due to fuller utilization of labor and increased value of leisure as per capita income increases. Hence the demand for new loans declines after a few years.

The average size of loans for the major activities varied according to the purpose for which a loan was taken and the sex of the borrower. For most of the activities, female members received smaller loans than male members. The average size also varied with the educational status of the members. Illiterate members received about 25 percent less than those with secondary or higher education.

Use of Loans

Table 21 presents the survey findings on distribution of loans according to the purpose for which the loans were taken. The results are broadly similar to those obtained from processing the official records of the Grameen Bank, as reported in Tables 8, 9, and 10. For male members, about 50 percent of the amount of the loans was taken for trading and shopkeeping, while for female members, about 75 percent of the loan amount was for livestock and poultry raising and for processing and manufacturing activities.

Table 22 shows the pattern of utilization of Grameen Bank credit as stated by the borrowers.[54] The important point to be noted is that only an insignificant proportion of the loans was diverted to consumption and other household needs. Only 0.7 percent of the money was used for consumption purposes, 4.3 percent for social ceremony, and 1.6 percent for repair of housing. Ninety-four percent of the money was used for investment in various agricultural and nonagricultural activities. About 4.3 percent of the total amount was borrowed for crop cultivation (Table 21), but 6.4 percent was utilized for this purpose, indicating marginal diversion of nonfarm loans into farming activities. Thirty-five percent of the total amount was used for trading and shopkeeping, and 32 percent for livestock and poultry raising—almost the same proportion that was borrowed for these purposes. It appears that the diversion of loans to consumption and social ceremony took place primarily at the expense of investment in processing and manufacturing activities.

The diversion of money across sectors will be better seen in Table 23, which shows the utilization pattern of loans by their initial purpose. Loans taken for shopkeeping and for transport and other services were mostly used for these purposes. But a large portion of the money taken for processing and manufacturing activities was diverted

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[54] It should be recognized here that the loans are fungible. The amount of money received could have substituted for own capital utilized in the enterprise before the loan was taken, which would now be available for consumption or meeting other household needs.

Table 22—Pattern of loan utilization, by sex of borrower, 1985

Utilization	Male Borrowers	Female Borrowers	All Borrowers
		(percent of current loan amount)	
Nonproductive	4.9	8.1	6.6
Consumption	0.5	0.9	0.7
Social ceremony	3.5	5.0	4.3
House repair	0.9	2.2	1.6
Productive	95.1[a]	91.9[a]	93.5
Crop cultivation	7.4	5.5	6.4
Livestock raising	19.9	33.1	26.8
Poultry raising	3.9	5.7	4.9
Processing and manufacturing	11.6	18.3	15.1
Trading and shopkeeping	43.7	27.3	35.1
Transport operations and other services	8.7	2.1	5.2
Total	100.0	100.0	100.0[a]

Source: Survey of 975 borrowers.

[a] Parts do not add to total because of rounding.

to livestock and poultry raising (26 percent) and trading (23 percent). This diversion reflects the low rate of return on capital for processing activities compared with that for trading and livestock raising.

Repayment Behavior of Borrowers

The traditional banking system rarely provides credit to the poor, since (1) they cannot provide collateral against which the loan can be granted; (2) they do not maintain accounts for preparation of bankable projects; and (3) they have a low repayment capacity because, at their subsistence level, the compulsion to consume the additional income is great.[55] The Grameen Bank is providing loans to these people without any collateral. It is thus important to investigate the repayment behavior of Grameen Bank members.

The monthly statement of the Grameen Bank for February 1987 reported that 97.4 percent of the money was recovered within one year after the date of issue and 98.6 percent within a period of two years.[56] The bank treats as overdue any loan amount that is not repaid within two years, since the loanable fund is borrowed for that term. Thus the bank regarded only 1.4 percent of loans as overdue. In actual practice, however, the borrower is expected to fully repay the loan within one year. From this point of view, the overdue amount was 2.6 percent.

An independent estimate of the loan repayment performance was made by asking the sample borrowers how many weekly installments had already been paid at the time of the interview and estimating how many were due to be paid from the date of issue of the loan. Each borrower has a passbook in which this information is recorded. The interviewer was asked to verify the response of the borrower by checking this passbook. The amount overdue is derived by multiplying the number of overdue installments (installments due to be paid minus the installments actually paid at the

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[55] Grameen Bank, *Consolidated Cumulative Statement as of February 28, 1987* (Dhaka: Grameen Bank, 1987).

[56] See, for example, the lenders' views about handling small industry loans in M. U. Ahmed, "Financing Rural Industries," pp. 75-76.

Table 23—Pattern of loan utilization, by purpose of loan, 1985

Utilization	Purpose of Loans: Crop Cultivation	Livestock, Poultry Raising, and Fisheries	Processing and Manufacturing	Trading	Shopkeeping	Transport Operations and Other Services
			(percent of current loan amount)			
Nonproductive	1.0	5.6	7.1	6.5	5.7	5.6
Consumption	0.0	0.6	1.2	0.4	0.6	0.6
Social ceremony	1.0	3.2	5.1	3.7	5.1	5.0
House repair	0.0	1.8	0.8	2.4	0.0	0.0
Productive	99.0	94.4	92.8	93.5	94.3	94.4
Crop cultivation	72.0	4.4	1.8	4.9	6.4	3.3
Livestock, poultry raising, and fisheries	4.5	66.4	25.8	12.2	1.1	2.0
Processing and manufacturing	0.8	12.5	41.9	2.2	0.7	0.0
Trading and shopkeeping	21.7	10.4	22.6	72.4	86.1	2.0
Transport operations and other services	0.0	0.7	0.7	1.8	0.0	87.1
Total	100.0	100.0	100.0[a]	100.0	100.0	100.0

Source: Survey of 975 borrowers.
[a] Parts do not add to total because of rounding.

time of the interview) by the amount to be paid per week. Thus a loan is treated as overdue even before the maturity period of one year if the borrower has not been regular in paying the weekly installments. Table 24 shows that only 0.5 percent of the amount of the loans was overdue beyond one year after issue of the loans to sample borrowers, and the amount unpaid in overdue weekly installments (before the end of the year) was only 3.3 percent of the amount borrowed. The sample survey thus confirms the excellent recovery performance shown in official records of the Grameen Bank.

Table 24 also shows that loan repayment performance was almost the same for male and female members, but varied across landownership groups and with length of membership in the bank. A large proportion of overdue loans was with nontarget-group households and longtime borrowers. Members who owned more than 1 acre of cultivated land had about 7.2 percent of the loan amount in overdue installments, compared with only 2.7 percent for members who owned no cultivated land. The amount overdue beyond one year was 2.4 percent for those with more than 1 acre, compared with only 0.4 percent for those with no land. Fourth-time borrowers had 9.5 percent of the loan amount in overdue installments, compared with 0.4 percent for first-time borrowers and 1.2 percent for second-time borrowers. Thus the longtime members appeared to be less committed to maintaining regular repayment. But all groups of borrowers had very little overdue beyond one year after the date of disbursement.

The repayment behavior of different groups of borrowers is seen more clearly in Table 25. Seventy-eight percent of borrowers had no overdue installments at the time of the 1985 survey. This figure was found to be the same as in a 1982 survey, thus showing the stability of the estimate.[57] More than one-third of the overdue cases

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[57] Hossain, *Credit for the Rural Poor*, p. 69.

Table 24—Extent of overdue loans, by type of borrower, 1985

Type of Borrower	Total Amount of Loans to Group	Overdue Installments[a]		Installments Overdue Beyond 52 Weeks	
		Amount	Share of Loan Amount	Amount	Share of Loan Amount
	(Tk 1,000)		(percent)	(Tk 1,000)	(percent)
Sex					
Male	1,441.5	49.7	3.4	4.8	0.3
Female	1,512.5	49.1	3.2	9.3	0.6
Landownership (acres)					
0.0	1,429.5	38.8	2.7	5.5	0.4
0.01–0.49	843.5	23.4	2.8	0.5	0.1
0.50–0.99	387.5	15.4	4.0	1.3	0.4
1.00 or more	293.5	21.2	7.2	6.9	2.4
Number of loans taken					
One	595.5	2.1	0.4	0.0	0.0
Two	1,211.5	14.3	1.2	3.0	0.2
Three	633.0	41.9	6.6	7.2	1.1
Four	299.0	28.5	9.5	3.9	1.3
Five or more	215.0	11.9	5.5	0.0	0.0
Total	2,954.0	98.7[b]	3.3	14.1[b]	0.5

Source: Survey of 975 borrowers.

[a] The amount due to be paid minus the amount actually paid at the time of the survey.

[b] Parts do not add to total because of rounding.

had one or two unpaid installments. Cases with 10 or more overdue installments were estimated at only 5.1 percent, which is an improvement over 1982, when this figure was estimated at 9.3 percent. The repayment performance was best for women borrowers—81 percent of them had no overdue installments, compared with 74 percent for men.

A sharp difference in repayment performance is noted among borrowers differentiated by length of membership in the bank. More than 62 percent of the members who had already taken five or more loans from the bank had overdue installments at the time of the 1985 survey, compared with only 3.3 percent for first-time borrowers and 10.5 percent for second-time ones. A

Table 25—Distribution of borrowers, by overdue and paid installments, 1985

Installments	Number of Loans Taken					Sex of Borrowers		
	One	Two	Three	Four	Five or More	Male	Female	Male and Female
	(percent of borrowers)							
Overdue installments	3.3	10.5	39.1	67.1	62.7	25.6	18.7	21.8
1–2	2.2	4.7	10.5	20.9	33.9	11.6	5.7	8.3
3–5	0.4	3.4	6.4	18.7	16.9	5.4	5.2	5.3
6–9	0.0	0.8	6.4	15.4	5.1	4.1	2.2	3.1
10 or more	0.7	1.6	15.8	12.1	6.8	4.5	5.6	5.1
No overdue installments	96.7	89.5	60.9	32.9	37.3	74.4	81.3	78.2
Exact number of installments paid	78.2	75.3	56.7	25.2	32.2	63.0	67.8	65.6
Advance installments paid	18.5	14.2	4.2	7.7	5.1	11.4	13.5	12.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Survey of 975 borrowers.

significant proportion of new borrowers pay installments in advance, presumably to become eligible for another, larger loan as soon as possible. This may be partly due to underestimation by both lender and borrower of the first loan amount that the latter can profitably use. Once in business, the borrower realizes the mistake and wants a larger loan. Since there is a tendency to repay from principal rather than from income, Grameen Bank has ruled that a loan cannot be fully repaid earlier than 40 weeks from the date of issue.

The recovery of Grameen Bank loans must be considered excellent when compared with the performance of other credit programs in Bangladesh. According to the agricultural credit review of 1983, conducted jointly by the government of Bangladesh and the International Development Association, the nationalized commercial banks showed 52 percent of their outstanding agricultural loans as overdue in June 1980 and 61 percent in June 1981.[58] Nearly half of the amount was overdue by more than two years. The agricultural development bank, which has a relatively better record of repayment, had 17 percent of loans overdue at the end of June 1982.

Some of the factors that have contributed to the excellent recovery of Grameen Bank loans are (1) the personal interest and close supervision of activities in the field by the managing director, who is also the founder of the bank; (2) the dedicated services of the bank workers, most of whom have taken the job as an opportunity to provide services to the poor rather than simply to earn an income for themselves; (3) the provision of loans for activities that generate regular incomes; (4) the procedure of collecting repayments in small amounts through weekly installments; and (5) the genuine credit need of the poor for profitable income-earning opportunities perceived by them.

In spite of the large increase in the number of bank branches, the managing director still maintains his personal contacts with the branches through frequent field visits and attendance at workshops. Workshops are arranged to bring together representatives of borrowers, center chiefs, and bank staff to discuss issues of bank operation and social matters such as family planning, marriage expenses, education of children, health and sanitation, and relations with local power holders. Top Grameen Bank managers attend these workshops to keep in touch with problems in the field. The managing director is also assisted in the field by a dedicated cadre of mid-level officers, many of whom were his students and were developed by him during the pilot experiment of the project near Chittagong University. With the increase in the number of bank branches, these officers now work as his primary contacts, keeping him constantly in touch with the problems of bank branches and the performance of the managers and bank workers. A decentralization of administrative and decisionmaking processes has also followed the expansion of the bank (see Chapter 4).

Bank employees are recruited after careful scrutiny of their knowledge of the living conditions of the rural poor and interest in serving them. Before employees are assigned to a branch, they are given intensive training for six months, mostly in the field, where they not only learn their duties and the rules and procedures followed by the Grameen Bank, but also observe and study the socioeconomic conditions in the countryside and the needs of the poor. The employees are then sent to existing branches to work as trainees. During this time they observe the operation of the bank, assist their counterparts in the branch, and write case studies on the life of the rural poor. Most employees who find the work difficult and not suitable for them leave the Grameen Bank at this time. Only those who pass the test of hard work are sent to their new duty stations as independent workers. Such intensive training helps build a dedicated cadre of bank employees who are really the key to the success of the Grameen Bank. They have not yet been influenced by the widespread corruptive practices elsewhere in the banking system.

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[58] Bangladesh/International Development Association, *Bangladesh Agricultural Credit Review, Statistical Annex* (Dhaka: Government of Bangladesh/IDA, 1983).

As already noted, Grameen Bank credit finances basically noncrop activities. These activities generate regular incomes, and as the loans are recovered in small installments on a regular basis, the clients find repayment easy. If the loans had to be repaid in one installment after one year, as is the case with agricultural lending in the country, the borrowers would find it difficult to accumulate the amount because, at their level of income, there is a tendency to divert increased income to consumption.

7

ECONOMIC EFFECTS

Methodological Issues

In the absence of comparable benchmark data, the effect of the Grameen Bank's operation on income and poverty had to be estimated through a "with" and "without" comparison of information collected in a one-time survey of households in five project villages covered by the bank and two control villages outside the bank's area of operation. The sample households were classified into four groups: (1) Grameen Bank members in project villages, (2) nonparticipating households within the target group (target-group households own less than 0.5 acre of cultivated land), (3) target-group households in the control villages, and (4) nontarget-group households (those who own 0.5 acre or more) in both project and control villages. Groups 2 and 3 have been used as alternative controls for comparison of the average values of the relevant variables with those for group 1.

This methodology is not without pitfalls.[59] There are problems with using either of the two groups as a control. The target-group nonparticipants in the project villages would have similar resource bases, but some of their sources of income would be affected by the bank's intervention. For example, income from agricultural labor would be affected by the withdrawal of bank members from the agricultural labor market, while the participants' access to credit for undertaking nonfarm enterprises might lead to some redistribution of nonfarm income from nonparticipant to participant households within the project village. The selection of control households from the target group in villages outside areas of the Grameen Bank's operation would eliminate these problems, but in practice it is difficult to find control villages that are exactly similar to project villages in all respects. The survey found that the control villages had a larger proportion of landless and near-landless households than the project villages, and that the average amount of land owned was less for the control villages, although the average amount of cultivated land owned was similar, because of greater participation of control households in the tenancy market.

The estimates obtained from the comparison may also suffer from the sample selection bias. It could be argued that the Grameen Bank initially moves into villages that have relatively high levels of income, as the market for nonfarm goods and services would be larger there and hence the demand for loans would be greater. Similarly, Grameen Bank participants may be better entrepreneurs than the nonparticipants and hence were probably better off before the intervention of the bank. A simple comparison of the project and control groups may thus overestimate the true effect.

In order to see the extent of the sample selection bias, a probit model was run by

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[59] Analysts of rural financial markets denounce the value of studies of the effect of credit programs. Von Pischke and Adams argue that measurement of the effects of a credit program should focus on "additionality," which is the difference between what happened under a project and what would have happened without it, and additionality is very difficult to measure at the farm level. David and Meyer argue that credit effect is very hard to isolate with the use of common social science research tools and the value of credit as a tool for development can be easily overestimated by ignoring problems such as fungibility of loan money and the interdependence of farm and household decisionmaking. See J. D. Von Pischke and Dale W Adams, "Fungibility and the Design and Evaluation of Agricultural Credit Projects," in *Rural Financial Markets in Developing Countries,* ed. J. D. Von Pischke, Dale W Adams, and Gordon Donald (Baltimore and London: Johns Hopkins University Press, 1983), pp. 74-83; and Cristina C. David and Richard L. Meyer, "Measuring the Farm Level Impact of Agricultural Loans," in *Rural Financial Markets,* ed. Von Pischke, Adams, and Donald, pp. 84-95.

Table 26—Statistical difference between project and control group households according to selected exogenous variables, 1984/85

Variable[a]	Sample of Members with Target-Group Nonparticipants in Project Villages (N = 137)			Sample of Members with Target Group in Control Villages (N = 132)		
	Regression Coefficient	t-ratio	Significance Level	Regression Coefficient	t-ratio	Significance Level
Constant	1.430	2.040	0.041	6.310	0.02	0.984
FSZ	0.056	0.960	0.339	0.099	1.54	0.123
AGE	−0.017	−1.830	0.067	−0.035	−3.25	0.001
EDN	0.022	0.820	0.414	0.065	2.30	0.022
LND	−0.470	−1.580	0.115	0.014	0.11	0.917
CPTLP	0.046	1.089	0.277	−0.005	−0.23	0.817
OCPP	−1.112	−1.870	0.062	−5.720	−0.02	0.986
$\bar{R}^2$	0.090			0.120		
Log-L	−94.900			−91.400		

Source: Household survey in project and control villages.

[a] FSZ is the number of family members; AGE is the age of the household head; EDN is the number of years of formal schooling completed by the household head; LND is the acreage owned by the household; CPTLP is the value of nonland fixed capital before joining the bank; and OCPP is a dummy variable representing the participant's major occupation before joining the bank.

regressing a dichotomous dependent variable, which measures participation in the Grameen Bank (1 for participants and 0 for nonparticipants), to a number of exogenous variables that are not supposed to be affected by the intervention made by the bank. The following regression model has been estimated:

$$MMBR = f(FSZ, AGE, EDN, LND, CPTLP, OCPP),$$

where MMBR is a dummy variable with value 1 for participants and 0 for nonparticipant households, FSZ is the number of family members, AGE is the age of the household head, EDN is the number of years of formal schooling completed by the household head, LND is the amount of land owned by the household (acres), CPTLP is the value of nonland fixed capital (in Tk 1,000) before joining the bank, and OCPP is a dummy variable representing the participant's major occupation before joining the bank, taking value 1 for agriculture and 0 for nonagriculture.

The results of the exercise for the two sets of samples (participants with the target-group nonparticipants in project villages, and participants with the target group in the control villages) are presented in Table 26. The Grameen Bank participants had larger families, were younger, better educated, and pursued more nonagricultural activities than the nonparticipants in both project and control villages. But within the project villages, the difference between the two groups was not statistically significant at less than 5 percent. Only with respect to age and occupation was the difference weakly significant at less than 10 percent probability. Compared with the target group in the control villages, the project group was significantly different with respect to age (younger) and education (higher levels of schooling). Thus the results obtained from comparison of the project group with control group 1 should not be seriously biased, but the positive results obtained from comparison with control group 2 may be biased upward.

Effect on Credit Markets

One of the basic premises of the Grameen Bank is that the poor nonfarm operators, particularly those employed in cottage industries and petty trade, have to depend on village moneylenders *(mohajons)* for capital. It is well known that the *mohajons* charge very high rates of interest on these informal loans (Table 3). An interest rate of 10 percent a month is common in informal markets. The *mohajons* sometimes control the input and product trade, and the nonfarm operator facing a shortage of capital sometimes gets raw materials on credit from a moneylender against the stipulation that the operator will sell the output through the lender.[60] By exercising monopoly control in the interlinked input, product, and capital markets, the *mohajon* can extract a large proportion of the current income of the borrower.[61] Lack of capital may also force many nonfarm operators to sell their services as laborers for a very low wage. This is observed especially in paddy husking and petty trade. Grameen Bank credit may enable nonfarm operators to become independent of the rural financial and market intermediaries and help this poor group to retain the income now extracted by the moneylenders.

The Grameen Bank collects information on the nature and extent of current indebtedness of prospective members by asking them to report the sources and amount of current debt (including credit that is not overdue) on the membership application form. This information may be underreported because of fear that the bank would not provide credit to an indebted household. Also, credit obtained in kind, in the form of raw materials, may not be reported, as this is not normally considered to be debt. This information was processed for the members of the branches under study. It was found that only 0.7 percent of Grameen Bank members had received credit from institutional sources before joining the bank (not shown in the table). Even the informal lenders do not regard these households as creditworthy. Only 5.7 percent of member households reported that they had debts with noninstitutional sources—3.4 percent from *mohajons*, 2.0 percent from friends and relatives, and 0.3 percent from other informal sources. The average size of the debt for an indebted household was Tk 1,502—Tk 964 with *mohajons* and Tk 2,684 with friends and relatives.

Since raw materials obtained on credit are not generally regarded as loans, the sample borrowers covered in the 1985 survey were asked to report the size of the working capital employed by them in an enterprise before joining the bank and the amount financed by noninstitutional sources. This information, too, may be inaccurate, especially for repeat borrowers, because of problems associated with memory recall. Nineteen percent of households reported receiving noninstitutional credit before joining the Grameen Bank (see Table 27). This proportion was reduced to less than 3 percent as a result of intervention by the bank. Thirty percent of the working capital of borrowers was financed with noninstitutional credit before joining the bank, but this was reduced to only 3 percent for 1985, indicating the overwhelming effect of the Grameen Bank on the operation of the informal credit market.

The effect of the bank on the rural credit market can be better assessed from Table 28, which presents the findings of the household survey in the project and control villages on the amount of loans taken from various sources during 1984/85. About 94 percent of member households received an average of Tk 3,300 from institutional (Grameen Bank) sources. The dependence of participants on noninstitutional sources was low when compared with similar groups of households in the project and control villages. Only 6 percent of Grameen Bank members received loans from noninstitutional sources, compared with about 18 percent of the bank's target group in the control villages and 20 percent among nonmembers

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[60] See M. U. Ahmed, "Financing Rural Industries," p. 71.

[61] Atiq Rahman, "Usury Capital and Credit Relations in Bangladesh Agriculture: Some Implications for Capital Formation and Capitalistic Growth," *The Bangladesh Development Studies* 12 (No. 2, 1979): 1-46. For studies on eastern India, which has socioeconomic environments similar to those in Bangladesh, see P. K. Bardhan and A. Rudra, "Interlinkage of Land, Labor and Credit Relations: An Analysis of Village Survey Data in East India," *Economic and Political Weekly* 13 (February 1978): 367-384.

Table 27—Noninstitutional credit as a source of working capital, 1985

	Before Joining Grameen Bank		During Year of Survey	
Type of Borrower	Households Receiving Noninstitutional Credit	Working Capital Financed with Noninstitutional Credit	Households Receiving Noninstitutional Credit	Working Capital Financed with Noninstitutional Credit
		(percent)		
Sex				
Male	23.6	29.7	5.2	4.3
Female	15.4	31.3	0.7	0.4
Occupation				
Industry	23.6	16.5	4.9	4.5
Trading and shopkeeping	24.5	30.8	3.8	3.2
Other	12.2	51.4	0.7	0.4
Total	19.1	30.0	2.8	3.0

Source: Survey of 975 borrowers.

within the target group in the project villages. Most institutional credit outside of the Grameen Bank was received by nontarget-group households; only 3 percent of the target group (in the combined categories B and C in the table) received such loans, compared with 28 percent of the nontarget group. Outside the bank, only 9 percent of households received institutional credit, which accounted for about 52 percent of the total amount of loans received by these households. With Grameen Bank intervention, the proportion of households receiving institutional credit increased to 30 percent and the share of institutional loans in total loans increased to about 78 percent.

Effect on Capital Accumulation

The most direct effect of the bank is on accumulation of capital, both working and fixed. A Grameen Bank loan is repaid in small installments every week, so it is easy for a borrower to pay an installment from income, leaving capital intact. A Grameen

Table 28—Amount of loans received from various sources, by different groups of rural households, 1984/85

		Noninstitutional Credit		Institutional Credit	
Household Category	Number of Loans	Households Receiving Loans	Average Loan Received per Household	Households Receiving Loans	Average Loan Received per Household
		(percent)	(Tk)	(percent)	(Tk)
A. Grameen Bank member	69	5.8	32	94.2	3,300
B. Nonparticipant within target group in project village	68	20.6	245	4.4	279
C. Grameen Bank target group in control village	63	17.5	298	1.6	16
D. Nontarget group	79	15.2	578	27.8	1,075
Total	279	14.7	345	30.1	1,192
Grameen Bank nonmember (groups B, C, and D)	210	17.6	448	9.0	500

Source: Household survey in project and control villages.

Table 29—Changes in working capital after joining Grameen Bank, by type of borrower, 1985

Type of Borrower	Number of Borrowers	Borrowers Reporting Working Capital		Amount of Working Capital per Borrower at Current Prices		
		Before Membership	At Time of Survey	Before Membership	At Time of Survey	Increase per Year[a]
		(percent)	(percent)	(Tk)	(Tk)	(percent)
Sex						
Male	441	54.0	85.0	1,237	4,141	56
Female	534	41.9	79.4	336	1,713	88
Occupation						
Processing and manufacturing	245	70.2	95.1	908	3,544	67
Trading and shopkeeping	319	49.2	87.5	1,166	4,083	59
Other	411	32.4	69.8	316	1,386	75
Total	975	47.4	81.9	743	2,811	64

Source: Survey of 975 borrowers.

[a] Calculated on the basis of an average length of membership of 2.25 years, after adjusting for inflation of 10 percent a year.

Bank member is expected to have a larger amount of capital when taking a repeat loan than at the time of becoming a member. Also, since the bank provides a repeat loan in a relatively larger amount, it is possible for the borrower to divert some credit or incremental income for making medium- and long-term investments, such as the purchase of cattle or acquisition of machinery, tools, and equipment.

The change in the status of borrower households vis-à-vis working capital after joining the Grameen Bank will be seen from Table 29. Less than half the borrowers reported investment in working capital before they joined the bank. At the time of the 1985 borrower survey the number was 82 percent, indicating a vast increase in the proportion of households undertaking new enterprises. The average amount of working capital per borrower household increased nearly four times, from Tk 743 to Tk 2,811, within about 2.25 years. This period was the average length of bank membership for the sample borrower households. (See Table 20 for distribution of sample borrowers by length of membership.) Even after adjusting for inflation, which has been about 10 percent a year, the average increase comes to a substantial 64 percent a year. This increase has been even faster for female borrowers and for households engaged in services and manufacturing. For other activities, such as livestock raising, investment in fixed assets is probably more important than working capital.

The effect of the Grameen Bank on accumulation of capital can also be assessed by differentiating the sample borrowers according to length of membership with the bank and looking at their investment behavior (see Table 30). About 80 percent of households reported accumulation of nonagricultural capital after joining the bank, and the average amount of investment was higher for longtime borrowers than for newer ones. Fifty-four percent of households reported some investment in crop cultivation after joining the bank. This type of investment increased up to the third year of membership and was lower for longtime borrowers. The marginal accumulation in crop cultivation also declined sharply, even for borrowers of less than three years' standing.

For investments in housing, education, and sanitation, which are not directly productive but would promote human capital formation in the long run, both the average and the incremental investments increased with length of membership in the bank. It appears that in the initial years, when the

Table 30—Accumulation of capital after joining Grameen Bank, by length of membership and sex of borrower, 1985

Length of Membership/ Sex of Borrower	Number of Borrowers	Nonagricultural Investment[a]		Agricultural Investment[b]		Social Investment[c]	
		Members Reporting	Average Amount per Borrower	Members Reporting	Average Amount per Borrower	Members Reporting	Average Amount per Borrower
		(percent)	(Tk)	(percent)	(Tk)	(percent)	(Tk)
Less than one year	269	79.6	1,377	48.3	1,002	82.5	662
One to two years	372	86.6	2,597	61.3	1,923	89.2	989
Two to three years	164	77.4	2,968	56.7	2,259	83.5	1,656
Three years or more	170	65.9	3,751	42.9	1,926	71.2	3,541
All borrowers	975	79.5	2,524	53.6	1,726	83.3	1,456
Male	441	81.4	3,505	54.0	1,813	87.1	1,892
Female	534	77.9	1,714	53.4	1,654	80.1	1,096

Source: Survey of 975 borrowers.

[a] Includes expenditures on purchase of transport and industrial equipment, and additions to working capital in nonagricultural enterprises.

[b] Includes expenditures on purchase of cattle, agricultural equipment, and land.

[c] Includes expenditures on housing, education, and sanitation.

level of investment is low and hence the productivity of capital is high, the tendency is to accumulate more in productive lines. A decline in the rate of return with increases in the volume of capital,[62] however, induces longtime borrowers to move to social investments and conspicuous consumption. The expenditure on social and religious ceremony (not shown in the table) is estimated at Tk 928 and Tk 801 for first- and second-time borrowers, respectively, but Tk 2,180 and Tk 4,783 for third-time and longer borrowers.

Table 31 shows how successive Grameen Bank loans contribute to the increase in equity (own investment) capital according to the length of membership of the borrower household. Average investment from own funds increased from Tk 870 for first-time borrowers to more than Tk 5,700 for members who had borrowed four times or more. The share of equity in total invest-

Table 31—Effect of Grameen Bank on growth of equity capital, 1985

Length of Membership	Average Amount of Current Loan	Average Accumulation of Capital After Joining Bank		Average Share of Equity in Accumulated Capital
		Total	Equity	
	(Tk)	(Tk)		(percent)
Less than one year	2,181	3,041	870	28.3
One to two years	3,205	5,509	2,304	41.8
Two to three years	3,702	6,883	3,181	46.2
Three years or more	3,450	9,218	5,768	62.6

Source: Survey of 975 borrowers.

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[62] This was found to be the case in an earlier evaluation of the Grameen Bank. See Hossain, *Credit for the Rural Poor,* p. 90.

ment increased from 28 percent for first-time borrowers to 63 percent for members borrowing four times or more.

An important asset for the rural poor is livestock. More than two-fifths of total loans disbursed by the Grameen Bank are now taken for livestock raising. Changes in the pattern of livestock ownership after Grameen Bank intervention are shown in Table 32, which compares the ownership pattern at the time of joining the bank (by processing information provided in the membership application form) with that at the time of the survey (from information reported by the sample borrowers). About 63 percent of households did not own any cattle at the time of joining the bank, but this figure had been reduced to 45 percent by the time of the survey. Also, a much larger proportion of households owned two or more cattle at the time of the survey than before joining the bank. The average number of cattle owned increased by about 67 percent during this period. The proportion of households owning goats, however, did not increase much, although the number of goats owned per household increased by about 18 percent.

Table 32—Changes in pattern of livestock ownership after intervention by Grameen Bank, 1985

Number of Animals Owned by Household	Ownership at Time of Joining Bank (N = 4,641)		Ownership at Time of Survey (N = 975)	
	Cattle	Goats	Cattle	Goats
	(percent of households)			
None	62.7	68.1	44.5	65.8
One	20.3	17.6	23.8	13.8
Two	12.0	9.1	21.8	11.0
Three	3.1	3.7	6.4	4.5
Four or more	1.9	1.5	3.5	4.7
Total	100.0	100.0	100.0	100.0[a]
	(number of animals)			
Average per 100 households	61	60	102	71

Sources: Grameen Bank membership application forms and the survey of 975 borrowers.

Note: N is the size of the sample.

[a] Parts do not add to total because of rounding.

Effect on Occupation and Employment

The main objective of the Grameen Bank is to create opportunities for a vast unutilized labor resource by extending credit facilities to poor men and women for self-employment activities. Any evaluation of the bank should thus quantify the extent to which this has been achieved. Two aspects of employment generation are highlighted here: generation of new employment for the previously unemployed and generation of additional employment for the underemployed.

The change in the principal occupation of borrowers as a result of Grameen Bank membership is shown in Table 33. About 31 percent of the borrowers reported themselves unemployed before joining the bank. Thus the bank helped to generate new employment for about one-fifth of its members. This new employment was generated mostly for female members, half of whom reported having no primary occupation before joining the bank; at the time of the survey this proportion had been reduced to 21 percent. Thus about one-third of the female members who had been unpaid domestic workers had become income earners. It is noteworthy that one-fifth of the female borrowers reported having no principal income-earning occupation at the time of the survey. Some of them may have taken a loan on behalf of the husband or the male head of household,[63] but some may have been engaged in livestock raising or cottage industry as part-time workers. About 44 percent of the sample female borrowers took credit for livestock

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[63] R. I. Rahman found that 12 percent of female borrowers surrendered the entire loan amount to their husbands or male guardians, but 77 percent of them utilized more than three-fourths of the loan themselves. See Rushidan Islam Rahman, *Impact of Grameen Bank on the Situation of Poor Rural Women*, Grameen Bank Evaluation Project Working Paper 1 (Dhaka: Bangladesh Institute of Development Studies, 1986), pp. 32-35.

Table 33—Changes in occupation of borrowers after joining Grameen Bank, 1985

Principal Occupation	Before Joining Grameen Bank			At Time of Survey		
	Male (N = 441)	Female (N = 534)	All (N = 975)	Male (N = 441)	Female (N = 534)	All (N = 975)
	(percent of borrowers)					
Cultivation of family farm	7.3	0.4	3.5	6.3	0.4	3.1
Agricultural wage labor	20.0	1.9	10.1	2.1	0.2	1.0
Livestock and poultry raising	0.4	0.9	0.7	6.5	7.2	6.9
Processing and manufacturing	17.2	38.4	28.8	16.6	53.4	36.7
Trading and shopkeeping	32.2	5.4	17.5	46.3	15.9	29.6
Transport operations	5.9	0.2	2.7	9.5	0.4	4.9
Construction and other services	10.4	2.4	6.1	12.7	1.9	5.3
Unemployed	6.6	50.4	30.6	0.0	20.8	11.4
Total	100.0	100.0	100.0	100.0	100.0[a]	100.0[a]

Source: Survey of 975 borrowers.
Note: N is the size of the sample.
[a] Parts do not add to total because of rounding.

raising, but only 7 percent reported it as their principal occupation at the time of the survey.

Only 7 percent of male members reported being unemployed before joining the bank. For them, new employment was created mostly in livestock farming. For those already employed, there was a change in occupational pattern away from agricultural wage labor to petty trade. The proportion of male members who reported agricultural wage labor as their principal occupation was 20 percent before joining the bank but only 2 percent at the time of the survey, while the number of those who reported trading as their principal occupation increased from 32 to 46 percent during this period. The withdrawal of this significant proportion of Grameen Bank members from the agricultural labor market is expected to have an indirect positive effect on employment and earnings of the remaining agricultural wage laborers who did not join the bank.

The generation of new employment is also reflected in changes in the proportion of household members participating in income-earning activities. The in-depth household survey collected information about the composition of the households from which labor force participation rates (workers as a proportion of household members) have been estimated for the project and control groups (see Table 34). The average household size for the sample villages was estimated at 5.60 persons, which is comparable to 5.74 estimated by a 1981/82 national survey[64] for rural areas. The proportion of children up to age 14 was, however, lower in the sample villages (41 percent) than in the country as a whole (47 percent), as estimated by the 1981 population census.[65] The estimated labor force participation rate was 33 percent for the survey sample, compared with 30 percent for the entire country in the 1983/84 labor force survey.[66]

The comparison between Grameen Bank members and nonparticipants in the target group showed a statistically insignificant difference in household size and com-

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[64] Bangladesh, Bureau of Statistics, *Report of the Bangladesh Household Expenditure Survey, 1981-82* (Dhaka: Ministry of Planning, 1986).

[65] Bangladesh, Bureau of Statistics, *Final Report of Bangladesh Population Census, 1981: Analytical Findings and National Tables* (Dhaka: Government Press, 1984).

[66] Bangladesh, *Labor Force Survey, 1983-84.*

Table 34—Labor force participation rates of members and nonparticipant groups, 1984/85

Variable	Member Households (N = 69)	Target-Group Nonparticipant Households Project Village (N = 68)	 Control Village (N = 63)	Nontarget Group Households (N = 79)	All Households (N = 279)
			(number of persons)		
Average size of household	5.14	4.90	5.03	7.06	5.60
Adults (age 15 +) per household					
Male	1.57	1.46	1.59	2.32	1.76
Female	1.41	1.37	1.33	2.06	1.57
Workers per household					
Male	1.59	1.40	1.43	2.00	1.62
Female	0.51	0.21	0.24	0.03	0.24
			(percent)		
Workers as percentage of all household members	40.9	32.9	33.2	28.8	33.2
Workers as percentage of adult household members	70.5	56.9	57.2	46.3	55.9
Female workers as percentage of female adults	36.2	15.3	18.0	1.5	15.3
Female workers as percentage of total workers	24.3	13.0	14.4	1.5	12.9

Source: Household survey in project and control villages.
Note: N is the size of the sample.

position. But the number of workers was higher for member households than for target-group nonparticipants in both project and control villages. Workers constituted 41 percent of all household members among bank participants, compared with 33 percent for nonparticipants in the same landholding group. The difference is, however, mostly due to female workers, who were 36 percent of adult females in the project group, compared with 15 to 18 percent in the control groups. The difference in the number of female workers between bank members and the control group is statistically significant at less than 5 percent probability. About 25 percent of the workers in member households were women, compared with 14 percent for nonparticipants in the target group and an almost insignificant 1.5 percent among nontarget-group households. The positive contribution of Grameen Bank in creating new employment for women, thereby reducing the dependency ratio in the households, is amply demonstrated by these figures.

The effect of Grameen Bank loans on reducing underemployment is difficult to quantify accurately without conducting a costly and time-consuming regular employment survey throughout the year. Instead, we asked respondents in the borrower survey to report their average number of days of employment per month and average number of hours worked per day in the occupation for which the loan was taken, both before they joined the bank and in the year of the survey. From this somewhat imprecise information it is possible to estimate standard eight-hour days of employment in the enterprise undertaken with the loan, which at least gives a qualitative indication of the change in underemployment as a result of Grameen Bank intervention (see Table 35).

Before joining the bank, an average worker in a member household was em-

Table 35—Increase in employment in activity for which loan was taken, by occupation and sex of borrowers, 1985

Occupation	Number of Members	Employment		Increase in Employment
		Before Membership	At Time of Survey	
		(eight-hour days/month)		
Crop cultivation	29	7.6	18.7	11.1
Livestock and poultry raising	319	3.4	16.7	13.3
Processing and manufacturing	245	10.8	22.0	11.2
Trading	274	4.7	16.0	11.3
Shopkeeping	45	8.6	18.5	9.9
Transport operations	43	4.9	20.3	15.4
Other	20	0.9	3.9	3.0
Total	975	6.0	18.0	12.0
Male	441	9.4	21.9	12.5
Female	534	3.3	15.0	11.7

Source: Survey of 975 borrowers.

ployed for about 6 standard days of work a month in the activity for which the loan was taken. At the time of the survey, such employment was estimated at 18 days. The Grameen Bank loans thus generated additional employment in that activity for about 12 days a month. Some of this additional employment may be due to reallocation of labor from other activities; for example, from agricultural wage labor for male workers and domestic labor for female workers. Adequate information is not available to quantify the extent of such reallocation. The additional employment generated in an activity was almost the same for male and female workers, although the average monthly employment for females was 7 days less than for males. Manufacturing and transport services were relatively more full-time occupations than trading and livestock raising. The additional employment generated was highest for transport services (15 days), but did not vary much for other occupations (10 to 15 days).

A separate survey of a subsample of 151 female borrowers and 241 other households covered in this study collected information on time allocation for one month by various members of the household to the activity organized by the female borrowers.[67] Female members worked an average of 4.9 hours a day (18 standard eight-hour working days a month), of which 4.2 hours (16 standard days a month) were spent in the loan-financed activity. In comparison, housewives in the target-group nonparticipant households spent 0.64 hours a day (2.4 standard days a month) in income-earning or expenditure-saving economic activities within the household, and housewives in nontarget-group households spent 0.55 hours a day (2.1 standard days a month) in these activities. This comparison suggests that the Grameen Bank loan helped to increase female employment by 16 standard eight-hour days a month. The survey also found that the activity undertaken by female borrowers provided employment to other members of the household for 2.6 hours a day per household, or about 10 standard eight-hour days a month.

Effect on Income

The findings reported in the previous section demonstrate that Grameen Bank credit has a positive effect on income. This section attempts to quantify this effect from direct information on income collected through the 1985 field surveys. However, accurate estimation of income is difficult, since the borrowers do not keep any records of their business. Thus the results may contain some margin of error.

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[67] R. I. Rahman, *Impact of Grameen Bank*, pp. 17, 53.

Table 36 shows the borrowers' perception of the effect of Grameen Bank membership on their economic condition. Only 1.9 percent of them reported that their economic condition had deteriorated after joining the bank, and another 5.7 percent reported that there had been no improvement. Thus an overwhelming majority (91 percent) thought that the bank had made a positive contribution to their standard of living. This positive response was slightly higher for male borrowers than for females. The stated primary reason for the improvement was accumulation of capital, while additional employment in productive work and fruit and vegetable growing were given as the most important secondary reasons (see Table 37).

Table 36—Borrowers' perception of change in their economic condition after joining Grameen Bank, 1985

Economic Condition	Male Borrowers (N = 441)	Female Borrowers (N = 534)	All Borrowers (N = 975)
		(percent)	
Improved	92.7	90.0	91.2
Unchanged	5.2	6.2	5.7
Deteriorated	1.4	2.2	1.9
No response	0.7	1.7	1.2
Total	100.0	100.0[a]	100.0

Source: Survey of 975 borrowers.
Note: N is the size of the sample.
[a] Parts do not add to total because of rounding.

The in-depth household survey in five project and two control villages collected detailed information on the gross value of output and the cost of production for different production and service activities in which the sample households were involved. Table 38 presents the estimates of income from this information for member households and for nonparticipant households within the target group in both project and control villages. The income effect of the Grameen Bank can be estimated by compar-

Table 37—Borrowers stated reasons for their improved economic condition after joining Grameen Bank, 1985

Reason	Primary Reason			Primary and Secondary Reasons[a]		
	Male	Female	Total	Male	Female	Total
			(percent)			
Free from clutches of *mohajons*[b]	12.4	5.3	8.6	33.3	13.5	22.9
Accumulation of capital	67.7	52.6	59.8	88.4	79.2	83.6
Additional employment in productive work	8.7	31.3	20.5	28.0	65.6	47.7
Increase in wage rate	1.0	1.4	1.2	7.8	11.4	9.7
More involvement in poultry raising	0.0	0.5	0.2	13.9	19.7	16.9
More involvement in vegetable and fruit growing	0.5	0.2	0.4	52.0	38.2	44.8
Additional investment in agriculture	2.8	1.4	2.0	27.3	14.2	20.4
Other	7.1	7.3	7.2	19.4	24.5	22.1
Total	100.0[c]	100.0	100.0[c]	270[c]	266[c]	268[c]

Source: Survey of 975 borrowers.
[a] Respondents were asked to report three factors behind the improvement in their condition, in order of importance. These columns show the distribution of all responses. The figures and the totals show that respondents reported, on average, 2.68 reasons.
[b] Professional moneylenders who are a primary source of informal, noninstitutional loans to the poor.
[c] Parts do not add to total because of rounding.

Table 38—Level and structure of household income for Grameen Bank members and comparable nonparticipant groups, 1984/85

		Target-Group Nonparticipants		Difference	
Income Component	Grameen Bank Members (Group 1)	Project Villages (Group 2)	Control Villages (Group 3)	Group 1 Over Group 2	Group 1 Over Group 3
		(Tk/household)		(percent)	
Agriculture	5,606	5,323	6,577	5.3	−14.8
Crop cultivation	2,782	2,199	2,312	26.5	20.3
Kitchen garden	512	305	567	67.9	−9.7
Livestock and fisheries	941	788	928	19.4	1.4
Agricultural wage labor	1,371	2,031	2,770	−32.5	−50.5
Nonagriculture	12,528	8,881	6,119	41.1	104.7
Processing and manufacturing	4,355	2,753	1,119	58.2	289.2
Trading	3,859	2,234	1,369	72.7	181.9
Transport operations	1,352	572	735	136.4	83.9
Nonagricultural wage labor	670	826	738	−18.9	−9.2
Other nonagricultural (earthwork and self-services)	2,292	2,496	2,158	−8.2	6.2
Household income	18,134	14,204	12,696	27.6	42.8
Per capita income	3,524	2,900	2,523	21.5	39.7

Source: Household survey in project and control villages.

ing the income of bank members with that for the other two groups.

The average household income for the bank members was about 43 percent higher than that for the target group in the control villages and about 28 percent higher than for the target-group nonparticipants in the project villages. The difference is statistically significant. The agricultural income, particularly income from cultivation of family farms, was broadly similar across the groups. The positive income effect was mainly due to large increases in income from processing and manufacturing, trading, and transport operations—activities financed by Grameen Bank loans. The total income from these three nonagricultural activities was about two times higher for bank members than for the target group in the control villages, and about three-fourths higher for members than for target-group nonparticipants in the project villages.

An important point shown in Table 38 is that income from wage labor and various self-services is substantially higher for nonparticipants (Tk 5,353 per household) than for bank members (Tk 4,333) within the project villages. This indicates that Grameen Bank contributes indirectly to the growth of income of nonparticipant households through some withdrawal of supply from the labor market on the part of members. In a study of the effect of the Grameen Bank on local power structures, Rahman interviewed 49 local leaders, and 43 of them complained that Grameen Bank activities had reduced the supply of agricultural laborers in the locality.[68] Based on their reports, it was estimated that the wage rate for agricultural laborers increased by 19 percent a year—from Tk 14.2 to Tk 24.5 a day within a three-year period. The increase was higher during the peak season (20 percent) than during the slack season (17 percent). For Bangladesh as a whole, the nominal agricultural wage rate increased by 16 percent a year during 1982-85, when the cost-of-living index increased by 10 percent a year. The

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[68] Atiur Rahman, *Impact of Grameen Bank Intervention on Rural Power Structure*, Grameen Bank Evaluation Project Working Paper 2 (Dhaka: Bangladesh Institute of Development Studies, 1986).

Table 39—Annual household income in project and control villages, by landownership group, 1984/85

Landownership Group	Share of Households in Group	Project Village	Control Village	Difference in Project Over Control Villages
(acres)	(percent)	(Tk/household)		(percent)
None	10.5	10,256	8,090	26.8
0.01–0.49	42.5	16,381	14,553	12.6
0.50–2.49	31.0	20,349	20,809	–2.2
2.50–4.99	11.0	29,110	29,549	–1.5
5.00 or more	5.0	41,074	46,776	–12.2
All groups	100.0	19,603	16,970[a]	15.5

Source: Household survey in project and control villages.

[a] The pattern of landownership is somewhat different in the project and control villages. To make the comparison meaningful, the average household income for the control villages has been estimated as weighted average by multiplying the group-specific average income by the proportion of households in each group in the project village.

increase in the real wage rate was higher in the project area.

An important question at this point is whether Grameen Bank intervention leads to an overall increase in rural income or merely achieves a redistribution of income from the rich to the poor—and among the poor, from nonparticipant households to participants. Table 38 shows that the average household income for nonparticipants within the target group in the project villages is 12 percent higher than that for the target group in the control villages. This difference is contrary to what would be expected had there been a redistribution of income from nonparticipants to participants among the poor.

Table 39 compares the income of different landownership groups for the project and control villages. It appears from the figures that the positive income effect was highest for the absolutely landless, followed by the marginal landowners. But the income of the nontarget-group households was lower in the project villages than in the control villages, and the difference was larger for the upper landownership groups. This indicates some redistribution of income from large-landownership groups to the landless. The comparison between average household incomes in the project and control villages, however, indicates that income in project villages may have increased by about one-sixth as a result of intervention by the bank.

Alleviation of Poverty

The most commonly used measure of poverty is the "head-count ratio." It measures the proportion of households or populations whose income falls below a threshold (termed a poverty line) required for meeting basic food and nonfood needs. To estimate the poverty line, a balanced diet consisting of food items typically consumed in a country and capable of ensuring a certain level of calorie and protein intake is valued, using representative prices. The expenditure on nonbasic food needs is then taken into account to determine the income at which the minimum balanced diet can be ensured. This information is then applied to the distribution of population according to per capita income groups to estimate the population whose income falls below the poverty line.

The minimum energy and protein requirements for the average Bangladesh population, as recommended by various institutions, vary significantly. Several studies of rural poverty in Bangladesh used a consumption bundle providing an intake of 2,112 calories and 58 grams of protein,

Table 40—Estimates of proportion of poor population among participants and target-group nonparticipants, 1984/85

Variable	Grameen Bank Members	Target Group Nonparticipants		All Households	
		Project Villages	Control Villages	Project Villages	Control Villages
Gini concentration ratio of income	0.257	0.254	0.285	0.283	0.281
			(percent)		
Proportion of moderately poor population	61.0	83.7	80.4	61.5	76.3
Proportion of extremely poor population	48.0	76.0	74.4	47.1	54.6

Source: Estimated from the income distribution data obtained through the household survey in project and control villages.

which by and large conforms to the minimum diet recommended by the Food and Agriculture Organization of the United Nations.[69] At the retail prices prevailing in selected cities in 1984/85, the cost of the consumption bundle is valued at Tk 9.58 per capita per day. On the basis of the assumptions that rural prices are about 80 percent of the urban level and that 80 percent of the poverty-level income is spent on food, the poverty line is estimated at Tk 3,500 per capita per year. In order to identify the hardcore poor, a line of extreme poverty is drawn at Tk 2,975, which would satisfy 85 percent of the required calorie and protein needs.

The degree of inequality in distribution of income for the different groups of households under study and the proportion of poor population obtained from the income distribution data are reported in Table 40. The Gini concentration ratio is lower among Grameen Bank members than among the target group in control villages, but is almost the same among members and nonparticipants in project villages. There was, however, a much higher concentration of population in the lower-income brackets in both control groups than in member households. For example, households earning up to Tk 2,000 per capita (nearly two-thirds of the poverty-level income) contained almost 50 percent of the total population in both control groups, compared with only 19 percent among bank members.

Table 40 shows the proportion of population living in moderate poverty at 84 percent for target-group nonparticipants in project villages, 80 percent for the target group in control villages, but 61 percent for Grameen Bank members. Those living in extreme poverty were estimated at 48 percent for members, compared with about 75 percent for both control groups. These figures suggest that the bank has been able to lift a significant proportion of its members out of poverty.

The effect on alleviation of poverty is also felt at the village level. The relative inequality in distribution of income was similar in project and control villages, but the incidence of absolute poverty was much lower in project villages. The proportion of moderately poor population was 62 percent in project villages, compared with 76 percent in control villages.

Improvement in the standard of living of Grameen Bank participants is also suggested by a comparison of expenditures on food and nonfood basic needs for different groups of households (Table 41). The per capita expenditure on food for member households was 8 percent higher than for nonparticipants in project villages, and 35 percent higher than for the target group in control villages. The expenditure on cloth-

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[69] Muqtada, "Poverty and Inequality," p. 59.

Table 41—Expenditures on basic needs by Grameen Bank members compared with control groups, 1984/85

				Difference of Project Over Control Groups	
Variable	Members	Nonparticipants in Project Villages	Target Group in Control Villages	Nonparticipants in Project Villages	Target Group in Control Villages
		(Tk/person)		(percent)	
Expenditure on food	1,965	1,823	1,456	8	35
Expenditure on cereals	1,287	1,271	1,044	1	23
Expenditure on noncereal food	578	552	412	5	40
Expenditure on clothing	170	151	129	13	32
		(Tk/household)			
Expenditure on education	156	152	105	3	49
Expenditure on health	225	210	170	7	32
Expenditure on housing	934	685	160	36	484
		(percent)			
Households incurring expenditures for education	43.5	32.4	31.7	34	37
Households incurring expenditures for housing	78.3	66.1	49.2	19	59

Source: Household survey in project and control villages.

ing for members was 13 percent higher than for nonparticipants in project villages and 32 percent higher than for the target group in control villages. The proportion of households that incurred expenses for children's education and housing improvement was larger for members than for the control groups. The investment in housing by members was about six times higher than that of the target group in control villages and about one-third higher than that of the target-group nonparticipants in project villages. Thus, the bank's emphasis on sustained improvement in the standard of living of its clientele through the social development program (see "Sixteen Decisions" in Chapter 4) seems to be supported by action on the part of its members.

8

COSTS OF OPERATION

Contrary to the conventional banking practice that the borrower comes to the bank to receive and repay a loan, the Grameen Bank goes to its clientele for both disbursement of loans and collection of repayments. The loans are small and repayments are collected in weekly installments. In addition, the bank takes the responsibility of giving its clientele intensive training in credit discipline and engages in a social development program. All this means that the paperwork and the staff time needed for servicing a given amount of loan are higher than for a normal rural credit program. The benefits of this intensive credit program, in the form of excellent recovery of loans and significant improvement of the economic condition of the extreme poor, need to be evaluated against the high costs of operation.

The annual reports of the Grameen Bank for 1984-86 state that the bank operates at a marginal profit. A close scrutiny of the accounts, however, shows that the credit operations of the bank involve losses that are compensated for by profits from deposits in other banks of a substantial amount of low-cost funds available from international donors.

Sources and Costs of Funds

The major sources of funds for the Grameen Bank are borrowings from the Bangladesh Bank and loans and grants from the International Fund for Agricultural Development (IFAD). A small amount is also available as loans from the Netherlands and the Ford Foundation. The Grameen Bank also draws on the deposits contributed by members to the Group Fund, the Emergency Fund, and special savings funds. In 1985 the bank started experimenting with deposit-banking at 25 branches, accepting deposits from all rural households, but these deposits still constitute an insignificant proportion of the funds. In 1986, deposits of nonmember households amounted to Tk 3.7 million—only 3 percent of the total deposited by members in the Group Fund.

Funds borrowed from the Bangladesh Bank under its refinancing scheme bear an interest rate of 8.5 percent a year and are repayable in 10 equal quarterly installments from the date of the loan. The Grameen Bank also borrows from the Bangladesh Bank under its rural housing financing scheme at an interest rate of 3.0 percent a year, repayable within 15 years on a quarterly installment basis. Two loans from IFAD have been obtained under two separate agreements between the Grameen Bank and the government of Bangladesh. The first loan is repayable in 15 years, beginning in March 1991, and bears an interest rate of 3.0 percent a year. The second loan, sanctioned in 1985, is repayable in 20 installments beginning in March 1995 at 2.0 percent annual interest. Financial accommodation through a temporary overdraft arrangement is available from a commercial bank at 16 percent a year. The Grameen Bank pays 8.5 percent annual interest on deposits, including the unutilized portion of the Group Fund.

Because of the widely varying rates of interest, the cost of Grameen Bank funds depends on the relative share of the various sources. The composition of the sources of funds and its change over the 1984-86 period is shown in Table 42. In 1986 the paid-up capital was only about 4 percent of the total liability of the bank, while borrowings accounted for 80 percent and deposits another 16 percent of the total liability. In 1985, borrowings from the IFAD loan accounted for 33 percent of total funds, and borrowings from the Bangladesh Bank were another 38 percent. In 1986, borrowings

Table 42—Shares of Grameen Bank funds from various sources, 1984-86

Source	1984		1985		1986	
	Amount Obtained	Share of Total Fund	Amount Obtained	Share of Total Fund	Amount Obtained	Share of Total Fund
	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)
Borrowings	311.3	82.6	433.9	79.5	716.8	79.6
Bangladesh Bank	154.6	41.0	206.6	37.8	80.8	9.0
International Fund for Agricultural Development	139.5	37.0	180.1	33.0	587.6	65.3
Other[a]	17.2	4.6	47.2	8.7	48.4	5.4
Deposits	38.3	10.2	79.8	14.6	145.0	16.1
Group Fund	24.5	6.5	48.7	8.9	81.9	9.1
Emergency Fund	6.4	1.7	12.6	2.3	22.0	2.4
Other	7.4	2.0	18.5	3.4	41.1	4.6
Paid-up capital	25.2	6.7	30.0	5.5	35.5	3.9
Reserves	1.6	0.4	2.3	0.4	2.7	0.3
Total	376.7[b]	100.0[b]	546.0	100.0	900.0	100.0[b]

Sources: Grameen Bank, *Annual Report*, 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
Note: n.a. means not available.
[a] Includes drawings from a loan from the Netherlands.
[b] Parts do not add to total because of rounding.

from the Bangladesh Bank declined substantially to only 9 percent of total funds, while the share of the IFAD loan increased to 65 percent. The share of deposits increased from 10 percent in 1984 to 16 percent in 1986, mainly because of increased accumulation in the Group Fund and Emergency Fund.

The estimated cost of Grameen Bank funds is reported in Table 43. As expected, the Bangladesh Bank is the highest-cost source, while IFAD is the lowest. In 1985 the average cost of funds was 5.8 percent, but the average came down to 3.6 percent in 1986, largely because of increased drawings from the IFAD loan. The interest payment on the IFAD loan in 1986 was about 66 percent higher than in the previous year, while the interest paid to the Bangladesh Bank declined by 36 percent in 1986. The total liability of the Grameen Bank in 1986 was 65 percent higher than in 1985, while the interest payment increased by only 4.7 percent in 1986.

Table 43—Changes in cost of Grameen Bank funds, 1984-86

Source	Amount of Interest Paid			Effective Cost of Funds		
	1984	1985	1986	1984	1985	1986
	(Tk million)			(percent)		
Borrowings	14.12	25.54[a]	23.55	5.1	5.9	3.3
Bangladesh Bank	11.16	18.30	11.68	7.2	8.9	n.a.
International Fund for Agricultural Development	2.32	5.32	8.84	1.7	3.0	n.a.
Other	0.64	1.91	3.03	3.7	4.1	n.a.
Deposits	1.84	4.09	7.47	4.8	5.1	5.2
Total	15.96	29.63	31.02	4.6	5.8	3.6

Sources: Grameen Bank, *Annual Report*, 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
Note: n.a. means not available.
[a] Parts do not add to total because of rounding.

Table 44—Trends in use of Grameen Bank funds, 1984-86

Item	Amount			Share of Total Property and Assets			Incremental Funds in 1986 over 1985	
	1984	1985	1986	1984	1985	1986	Amount	Share of Total
	(Tk million)			(percent)			(Tk million)	(percent)
Cash balance[a]	20.0	19.1	19.4	5.3	3.5	2.2	0.3	0.1
Loans and advances[b]	177.5	246.1	331.7	47.1	45.1	36.9	85.6	24.2
Fixed- and short-term deposits	146.5	218.5	435.5	38.9	40.0	48.4	217.0	61.3
Fixed and other assets[c]	32.7	62.3	113.3	8.7	11.4	12.6	51.0	14.4
Total property and assets	376.7	546.0	900.0[d]	100.0	100.0	100.0[d]	354.0[d]	100.0

Sources: Grameen Bank, *Annual Report*, 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
[a] A large part of the cash balance was in short-term deposit accounts with other banks.
[b] Includes loans given for house-building purposes.
[c] "Other assets" includes interest accrued on the loans but not yet recovered.
[d] Parts do not add to total because of rounding.

Use of Funds and Income

The Grameen Bank operates to mobilize the poor from households with less than 0.5 acre of land and provide loans to them to improve their living standard. All of the bank's work centers around this activity and the staff are recruited for this purpose. The bank earns 16 percent interest annually on the total amount of outstanding loans with members, which is normally about 50 percent of the amount of loans disbursed to members during the year. The bank also provides housing loans up to Tk 18,000, which are recovered in weekly installments for periods of up to 10 years. Housing loans bear an interest rate of 5.0 percent a year. The income from housing loans, however, is insignificant. By the end of 1986, the cumulative amount disbursed for housing was only Tk 27 million—about 1.8 percent of the amount of normal loans. The actual amount of interest received on loan operations was 13.2 percent of the amount of loans in 1986—lower than in 1985 (14.4 percent).

As shown in Tables 44 and 45, a major source of Grameen Bank's income is from investment of a substantial part of available funds in fixed- and short-term deposits with other banks. This has become a highly profitable line of business, since the funds are available at very low cost (particularly from the IFAD loan), while fixed-term deposits

Table 45—Sources and composition of Grameen Bank income, 1984-86

Source of Income	Amount			Share of Total Income		
	1984	1985	1986	1984	1985	1986
	(Tk million)			(percent)		
Interest on loans and advances	23.39	35.55	43.91	66.1	54.1	48.8
Interest on fixed- and short-term deposits	11.90	29.77	45.68	33.6	45.3	50.8
Interest on government treasury bills	0.09	0.36	0.31	0.3	0.6	0.4
Total	35.38	65.69[a]	89.90	100.0	100.0	100.0

Sources: Grameen Bank, *Annual Report*, 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
[a] Parts do not add to total because of rounding.

Table 46—Trends in cost of administration of loan operations, 1984-86

Item	Total Expenses			Expenses as Share of Total Liability			Expenses as Share of Amount of Loans		
	1984	1985	1986	1984	1985	1986	1984	1985	1986
	(Tk million)			(percent)			(percent)		
Salary and allowances	9.43	25.53	43.76	2.5	4.7	4.9	5.3	10.4	13.2
Other expenses	4.53	8.44	13.67	1.2	1.6	1.5	2.6	3.4	4.1
Depreciation	0.71	1.08	1.44	0.2	0.2	0.2	0.4	0.4	0.4
Provision for bad debt	0.50	0.60	1.10	0.1	0.1	0.1	0.3	0.2	0.3
Total	15.17	35.65	59.96[a]	4.0	6.5[a]	6.7	8.6	14.5[a]	18.1[a]

Sources: Grameen Bank, *Annual Report,* 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).

[a] Parts do not add to total because of rounding.

earn interest of 14.0 percent a year and short-term deposits, 8.5 percent. Very little staff time is needed for these financial transactions. In 1986 these deposits accounted for 48 percent of total property and assets—an increase from 39 percent in 1984. The interest earned on the deposits increased by nearly three times during 1984-86, while the interest earned on loans and advances to Grameen Bank members increased by 88 percent in this period. In 1984 the interest on these deposits accounted for about one-third of the income of the bank. By 1986 almost half of the bank's income came from this source.

In 1986 the incremental fund was Tk 354 million more than in 1985 (80 percent was obtained through additional borrowing, and 18 percent through additional deposits). Only 24 percent of the incremental fund was used for loans and advances, compared with 61 percent for additional investment in fixed- and short-term deposits and 14 percent for accumulation of assets (Table 44).

Cost of Administration

The extent and trends of operating expenses of Grameen Bank (excluding the cost of funds) are shown in Table 46. The major expenses are the salary and allowances of the staff (73 percent in 1986) and these have increased at a faster rate than other expenses. The bank makes very little provision for bad debt, which is based on an estimate of the actual amount of loans and advances remaining unrealized after a certain (unspecified) period of time. In 1986 the costs of operation stood at 6.7 percent of the total amount of funds. The incremental cost in 1986 over 1985 was 6.9 percent of the incremental fund handled by the bank.

Because the bank's activity centers around the mobilization of the poor and the administration of loans to them, the cost of its operation should be related to the amount of loans and advances rather than to total funds handled by the bank. This is shown in Table 46. In 1986 the costs of operation stood at 18.1 percent of the amount of loans and advances—a figure that must be regarded as very high. With the expansion of the bank, the costs of operation have increased rapidly (8.6 percent in 1984 and 14.5 percent in 1985), mostly because of increases in salary and allowances, which were only 5.3 percent of the amount of loans and advances in 1984, but nearly doubled to 10.4 percent in 1985 and further to 13.2 percent in 1986. The large increase in staff costs in 1985 was due to salary increases for government officials that were effective from June 1, 1985. The increase in staff costs continued in 1986 because the higher salaries were paid for only seven months in 1985, but for the full year in 1986. The magnitude of staff costs at the present level of salaries is thus reflected by the 1986 figures.

It should, however, be recognized that during this expansion phase the costs of operation are expected to be high because of the large number of new branches opening every year. In 1985 the bank opened

Table 47—Unit costs of operation of bank branches, by age of branch, 1984/85

Age of Branch	Salary and Allowances	Other Expenses	Total Expenses	Amount of Loans Outstanding with Borrowers[a]	Expenses as Share of Outstanding Loans
		(Tk thousand)			(percent)
Up to 6 months	30.8	9.6	40.4	165	24.5
6 months to 1.0 year	46.0	13.0	59.0	365	16.2
1.0–1.5 years	72.8	15.8	88.6	1,041	8.5
1.5–2.0 years	87.8	17.8	105.6	1,576	6.7
2.0–2.5 years	94.0	19.6	113.6	2,015	5.6
2.5–3.0 years	100.8	18.8	119.6	2,198	5.4
More than 3.0 years	107.6	20.8	128.4	2,259	5.7

Source: Compiled from unpublished information sent by the branches to the head office of Grameen Bank.

[a] The figures are averages for the beginning and the end of the year, except for the first two age categories, for which the figures refer to the end of the period.

74 new branches—nearly half of the number in operation at the end of 1984. In 1986 another 69 branches were added. The new branches take some time to reach full operation but have a fixed start-up cost. For older branches the costs of operation may be lower, as these branches should be able to expand their business without adding much to the fixed cost.

In order to see the extent to which the bank branches reap economies of scale with age, detailed information was obtained on costs of operation and amount of business for each branch for the six-month period from January to June 1985 and processed according to the age of the branches. The results are shown in Table 47. The six-month figures are multiplied by two in order to get an estimate for fiscal year 1984/85. The number of outstanding loans with borrowers increases rapidly with the age of the branch, but for branches more than two years old the increase in the amount lent is only marginal. The data indicate that a branch reaches maturity after about two years, when it handles, on average, outstanding loans of about Tk 2 million. The older branches may not have much underutilized capacity to increase business by expanding the coverage of members, although a vertical expansion is possible by increasing the average size of individual loans or increasing the number of loans for collective enterprises. At 1984/85 prices the operating costs of branches more than two years old were about 5.6 percent of the amount of outstanding loans, compared with more than 16.0 percent for branches from six months to one year old. Assuming a 100 percent salary increase effective June 1, 1985, and an unchanged amount of business, the costs of operation in 1986 for branches more than two years old would be roughly 9.3 percent, compared with 27 percent for branches from six months to one year old and 18.0 percent for all branches and higher-level supervisory offices. Thus nearly half of the existing cost of administration may be due to start-up costs.

Profitability and Implications for Subsidy

The profit-and-loss account of the Grameen Bank is summarized in Table 48. In 1984 the bank operated at a profit amounting to about 2.8 percent of the volume of loans and advances, but in 1985 and 1986 it just broke even.[70]

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[70] The small negative profit for 1986 shown in Table 48 does not appear in the provisional profit-and-loss account of the bank in its 1986 *Annual Report*. This is because of the provision of Tk 1.1 million in loan losses (bad debt), which is taken out of the expenditure account and shown in the balance sheet, where the amount of loans and advances is the reported net of the bad debt.

Table 48—Profit-and-loss accounts, 1984-86

Item	Amount			As Share of Loans and Advances		
	1984	1985	1986	1984	1985	1986
		(Tk million)			(percent)	
Income	35.38	65.69	89.90	19.9	26.7	27.1
Loan operation	23.39	35.56	43.91	13.2	14.5	13.2
Other operations (investments in fixed- and short-term deposits)	11.99	30.13	45.99	6.8	12.2	13.9
Expenditures	31.13	65.27	90.99	17.5	26.5	27.4
Cost of funds for loan operation	8.10	14.19	11.94	4.6	5.7	3.6
Cost of funds for other operations	7.86	15.43	19.09	4.4	6.3	5.8
Cost of administration of loan operation	15.17	35.65	59.96	8.6	14.5	18.1
Profits	4.90	0.46	−0.75	2.8	0.2	−0.2
Loan operation	0.12	−14.28	−27.99	0.1	−5.8	−8.4
Other operations	4.13	14.70	26.90	2.3	6.0	8.1
Sundry income	0.65	0.05	0.34	0.4	. . .	0.1

Sources: Compiled from Grameen Bank, *Annual Report,* 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).

During 1985 and 1986 the margin of profit was eliminated because of the large increase in salary and allowances. However, the bank incurs substantial losses on account of loan operations that are made up by profits from the deposit of loanable funds in other banks.

In 1986 the average cost of funds was 3.6 percent, while the income from fixed- and short-term deposits was 10.6 percent of the amount deposited on these accounts (Tables 44 and 48) and 13.9 percent of the loans and advances. Thus the bank was able to make a profit on this financial transaction to the extent of about 7.0 percent of the amount used for this purpose. The profit on this account was about 10.3 percent of the amount of loans and advances made to bank members. The large profit was made possible by the bank's access to low-cost credit available from the IFAD loan at only 2.0-3.0 percent a year. But even if the Grameen Bank had drawn on the funds from the Bangladesh Bank and the deposits in the Group Fund and other funds, it could have made some profit on this financial transaction, since the cost of funds from those sources is 8.5 percent a year.

The cost of the Grameen Bank's loan operation is substantially higher than the 16.0 percent rate of interest it charges on the loans. In 1986 the cost of administration was 18.1 percent of the total amount of loans, which together with the 3.6 percent cost of funds puts the total costs of operation at 21.7 percent. If the low-cost IFAD loan had not been available, the funds would have cost 8.5 percent and the costs of operation would have been about 26.6 percent. Even if the bank could reduce its cost of administration to 9.3 percent a year, as shown by the experience of branches that are more than two years old, the 8.5 percent cost of funds and an assumed 2.5 percent for overhead expenses (for supervision by area, zone, and head offices) would make the operating costs about 20.3 percent.

The Grameen Bank thus needs a subsidy for its operations. In 1986 the cost of loan operations was Tk 71.9 million (Table 48) while the income from loans and advances was 43.9 million, implying a subsidy rate of about 39 percent. If the funds had to be borrowed at 8.5 percent a year, the costs of operation would come to Tk 89.8 million, and the subsidy to 51 percent. The bank has so far managed on its own by drawing on the IFAD loan in excess of its actual needs for loans and advances. If this situation were to change adversely for the bank, it would become difficult to break even, and the bank would have to seek a direct subsidy from the government or increase the rate of interest charged to the borrower.

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CONCLUSIONS AND LESSONS OF EXPERIENCE

It is clear from this study that the Grameen Bank has made a positive contribution to the alleviation of poverty in the area of its operation. The bank has successfully reached its target group with credit, and has ensured both productive utilization of loans and their recovery in due time, thus helping to improve the living standard of more than 90 percent of the participants. But the bank has so far covered only about 13 percent of the target group in the districts under its operation and 4 percent of the target group throughout Bangladesh. The question remains as to whether the bank can be extended widely enough to have a significant effect on the alleviation of poverty nationally, and whether the model can be replicated in other countries.

Constraints to Expansion

An important factor in determining the successful expansion of the Grameen Bank from the supply side is institutionalization of management so that it no longer depends on the personal leadership of the bank's founder-managing director. Since 1983 the bank has made good progress toward that end. Initially, the managing director participated in the recruitment and training of all bank workers and directly supervised their activities. With the expansion of the bank, a decentralization of administration has taken place, with responsibilities and decisionmaking power vested in a dedicated cadre of midlevel officers who were developed during the 1976-82 period of experimentation with the project. Incentives for hard work have been maintained through quick promotions and transfers based on performance in the field. Borrowers' representatives, center managers, and bank officials meet frequently in regional workshops to discuss important issues pertaining to the operation of the bank and the lives of the borrowers. Senior management personnel attend these workshops to keep constantly in touch with problems in the field, and the lessons learned are often translated into policy changes. Mainly owing to the decentralization of administration and to flexible and responsive management, the Grameen Bank has been able to confine its services to its target group and ensure excellent recovery of loans in spite of the large expansion that has taken place since 1983.

Another factor on the supply side is whether the Grameen Bank can provide its intensive services without depending on subsidies from outside sources. In spite of opening a large number of new branches, the bank just broke even during 1985 and 1986 at the 16 percent rate of interest it charges on loans. This was possible, however, because of substantial profits earned by keeping part of its low-cost loanable funds (obtained from an IFAD loan) in fixed- and short-term deposits with other banks, which cannot be a long-term source of income. The actual loss on the credit operation in 1986 was 5.7 percent of the outstanding loans, and at the imputed cost of the loan funds at which other financial institutions borrow (8.5 percent a year), the loss would have been about 10.0 percent. The loss is largely due to the pressure of higher salaries and inflation on the cost, a situation that may continue. The increase in income would not be high enough to cover the rising cost because of the Tk 5,000 limit on individual loans. The amount of outstanding loans with the borrowers of an average branch reaches Tk 2 million within a period of two years but increases very little thereafter. Considering the Grameen Bank's effect on poverty alleviation, the government may decide to provide a direct subsidy to the bank, but with the bank's rapid expansion the subsidy might be a burden to the government budget.[71] It appears that the bank may have to consider some policy changes for rapid expansion of its operation.

First, the Grameen Bank might increase the 16 percent annual interest charged on loans. This could be done, without increasing the borrower's transaction cost, by reducing the proportion of the loan that has to be deposited in the Group Fund. The Group Fund is a sore point with borrowers, as they cannot reclaim the money when they leave the group. The fund imposes an additional effective rate of interest of about 10 percent of the principal outstanding with the borrower for a year. Also, only about one-sixth of the Group Fund is actually used for the purpose for which the fund was created. If the contribution to the fund were reduced from 5 percent of the loan to 2 percent, the rate of interest could be increased from 16 to 22 percent without increasing the effective transaction cost of the loan to the borrower. In this case, the increase in the nominal rate of interest should not reduce the demand for loans.

Another consideration should be an annual upward revision of the maximum limit for an individual loan, at least in line with the rate of inflation. This would increase the amount of business and the income of the older branches.

The bank might also require repeat borrowers to make repayment in monthly or even quarterly installments, which would reduce the paperwork and the cost of operation. Those who have increased their income sufficiently might be allowed to graduate and seek credit from other banks. Longtime borrowers do not pay weekly installments on a regular basis, in any case, but they do make repayment within one year.

To increase the amount of business per branch, the bank could extend its credit operations to small farmers to provide short- and medium-term agricultural loans. Such loans might be repaid in seasonal installments collected immediately after harvest. Economies of scale could also be realized by providing more loans for collective enterprises.

Finally, if the rate of interest on the loans were raised, the Grameen Bank could profitably move into savings mobilization by accepting deposits at rates of interest similar to those paid by other banks. Grameen Bank branches are generally located in more interior areas of Bangladesh than are branches of commercial banks and hence can attract more customers. The Grameen Bank could also promote deposits from its target group, who are shy about depositing the small amounts they save in commercial banks. These deposits could form an important source of loanable funds for future expansion of the bank.

From the demand side, a major constraint to expansion of the bank could be the small size of the market for nonfarm goods and services financed with Grameen Bank loans. It can be argued that Grameen Bank borrowers have not yet faced this problem because the bank is still operating within a small area, and hence the members can count on markets outside the locality. With expansion of Grameen Bank operations, the competition among nonfarm producers would increase and the members would need to count more and more on their own local markets, which might lead to lower prices and lower productivity of self-exploitation of labor. It is true that at the present low level of income, the market served by Grameen Bank borrowers is small. But from the dynamic point of view, the size of the market may not pose a serious problem for expansion (for further elaboration see the Appendix). As agricultural income increases through technological progress, the market for nonfarm goods and services increases more than proportionately.[72]

The Grameen Bank target group comprises about half of the national population, and as their income rises they will demand one another's products and services, thus mutually expanding the market. The demand for food induced by the growth in nonfarm income, unlike demand from growth in agricultural income, is met by production outside the family, thereby stimulating demand for trading and transport services. To the extent that excess production capacity exists in other sectors and capacity utilization is constrained by the lack of effective demand and by underdeveloped trading and transport services, the alleviation of poverty and the development of petty trade could stimulate the growth of production in other sectors, leading to a second round of expansion in the market for nonfarm goods and services. Also, many of the products that the Grameen Bank finances, such as livestock, handloom products, wood and bamboo furniture, and fixtures (carpentry), have strong markets both within the country and abroad.

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[71] The deficit in 1986 was Tk 28 million, amounting to 2.5 percent of the allocation to rural development activities in the annual development program for 1985/86.

[72] Mellor and Lele, "Growth Linkages," pp. 35-55; and Hossain, "Agricultural Growth Linkages," pp. 1-30.

The vertical expansion of the bank may be constrained by the low level of productivity in many activities that the bank's credit finances. This is known to be a particularly serious problem for the cottage industry sector, which receives about one-fourth of Grameen Bank loans.[73] It was observed in a previous study that with every repeat loan, the size of the loan increases, but the income increases at a much smaller rate because the rate of utilization of the loan for capital accumulation declines and the rate of return on capital also falls.[74] The same indication is obtained in the present study by the finding that longtime Grameen Bank members spend proportionately less on nonagricultural investment (relative to social investment) than do new members.

The bank management is aware of this problem, and to circumvent it the bank encourages members to take loans for collective enterprises so that they can reap economies of scale in business and can jointly own improved technology, thereby increasing labor productivity. But the success of the bank in this field has been limited. The collective enterprises have faced severe management problems, and widespread failures have put pressure on solidarity among members in many groups and centers. This has led Grameen Bank management to change its policy regarding the undertaking of collective enterprises. The bank now takes direct responsibility for initial management of the enterprises through joint ownership with the borrowers, and plans to hand over the management and full ownership after completion of a learning period by the borrowers. It is too early to evaluate the effect of this policy change. Another factor behind the widespread failure of collective enterprises may have been adherence to the same loan repayment procedure as that for individual loans (weekly repayment over a period of one year), which does not suit the financing of these relatively long-term fixed investments. To induce organization of collective enterprises, the bank may have to consider disbursing long-term credit and recovering it in seasonal (for agricultural investment) or annual installments.

Lessons of Experience

In 1984, in a study prepared for an IFAD midterm evaluation of the Grameen Bank, Dharam Ghai pointed out a number of lessons that can be learned from the bank's experience in planning and implementing development activities.[75] At that time the bank operated 89 branches and covered 70,000 members. It now operates more than 300 branches and has mobilized more than 250,000 households. But Ghai's observations are still valid today.

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[73] For evidence of low productivity of a large number of cottage industries, see Mahabub Hossain, "Productivity and Profitability in Bangladesh Rural Industries," *The Bangladesh Development Studies* 12 (March-June 1984): 127-161; and Hossain, *Credit for the Rural Poor,* pp. 77-94.

[74] Hossain, *Credit for the Rural Poor,* pp. 90-92.

[75] Dharam Ghai, *An Evaluation of the Impact of the Grameen Bank Project* (Dhaka: Grameen Bank, 1984).

The Grameen Bank experience shows the vital importance of credit as an entry point for a program of social and economic development. If a program is to have an appeal for people living in abject poverty, it must offer them clear and immediate prospects for economic improvement. It is easy to sell other interventions for social development, however unconventional they may appear (as demonstrated by the acceptance of physical training and parades by traditional Muslim women), once improvements in standards of living are demonstrated. The bank has also shown that it is possible to devise projects that directly benefit the extreme poor.

The Grameen Bank experience also brings out the importance of appropriate training and orientation of the field staff for successful accomplishment of a project. The key to the success of the Grameen Bank is the orientation, approach, and human qualities inculcated in the bank workers through a training program based largely on "learning by doing," that is, through observation of and participation in the ongoing activities. Before they start work on their own, prospective staff are required to observe critically the workings of the rural economy and society and the plight of the rural poor. This helps them to understand the philosophy and approach of the bank and to develop qualities required for inspiring trust and confidence in the target group. The bank workers have demonstrated that under appropriate conditions, the idealism and energy of youth can be harnessed to combat poverty and underdevelopment.

The bank has clearly demonstrated that lack of collateral should not stand in the way of providing credit to the poor. The poor can utilize loans and repay them if effective procedures for bank transactions with them can be established. These procedures may differ according to the socioeconomic environment. In the Bangladesh context, formation of groups with a small number of like-minded people has worked well, and group solidarity and peer pressure have substituted for collateral. Other innovations of the bank are taking the bank to the people, rather than people to the bank; recovering loans in small weekly installments; and developing collective funds with compulsory savings from individuals for their mutual benefit.

The recent literature on rural financial markets emphasizes that the widespread failure of the rural credit program to achieve its objectives is attributable to following a low-interest-rate policy.[76] This policy led to rationing of credit, which benefited the upper-income groups and nonagricultural sectors because of their access to administrators, while it adversely affected mobilization of savings. The Grameen Bank experience shows that high-cost credit can keep the influential nontarget group away from a targeted credit program, but more importantly, it demonstrates the need to develop appropriate institutions for the delivery of loans.[77] Even a high-interest-rate credit program could fail because of corruption and mishandling of funds by bank staff, while an institution like the Grameen Bank is capable of successfully implementing a highly subsidized low-interest-rate credit program.

Replicability in Other Countries

The Grameen Bank is an innovative credit program and has attracted the attention of a large number of countries and international donors.[78] It has been visited by high-level government officials from Nepal, Malaysia, the Philippines, Indonesia, and the Solomon

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[76] For a survey of the literature, see Adams and Vogel, "Rural Financial Markets"; and Avishay Braverman and J. Luis Guasch, "Rural Credit Markets and Institutions in Developing Countries: Lessons of Policy Analysis from Practice and Modern Theory," *World Development* 14 (No. 10/11, 1986): 1253-1267.

[77] The Grameen Bank experience supports the contention of Braverman and Guasch that a systematic and rigorous analysis of institutions and institutional environments is essential for understanding and implementing effective policy reforms of rural credit markets. Braverman and Guasch, "Rural Credit Markets," p. 1253.

[78] Mohammad Yunus, "The Grameen Bank: As I See It," International Labour Organisation, Geneva, November 1986 (mimeographed).

Islands, and by nongovernmental organizations and interested individuals from Kenya, Tanzania, and Rwanda. The Economic and Social Commission for Asia and the Pacific (ESCAP) organized a "Study Tour of Grameen Bank" for government representatives, bankers, and female program leaders of the region. IFAD is trying to launch a Grameen Bank-type credit program in Malawi. Malaysia has already formulated a project to experiment with such credit for the poor in Selangor State. Thus there is widespread interest in trying the Grameen Bank approach to credit in other countries. But will it work?

The Grameen Bank concept of generating self-employment through credit should work in countries with widespread poverty and underemployment. As long as there is surplus labor with little opportunity cost (under extreme poverty, leisure has little value), and labor can be transformed into salable commodities and services with a small amount of capital, there should be demand for Grameen Bank-type loans. And if the need for credit is genuine, and the transaction cost is such that it can be profitably used to increase household income, recovery of loans should not be a problem.

But it may not be possible to replicate universally the entire Grameen Bank approach to delivery of credit. Some elements of this approach, like formation of small homogeneous groups for group guarantee of loans and supervision of loan utilization, recovery of loans in small regular installments, and institutions for collective savings, could work well across different environments, but elements like taking the bank to the people and intensive interaction of bank staff with borrowers may not be appropriate and could become too costly for sparsely settled environments. The Grameen Bank approach has a fair chance of success in densely settled, poverty-stricken areas of Asia, but for Africa an appropriate delivery mechanism has to be worked out through trial and error. An approach or method cannot be replicated in a fixed, prescriptionary sense. Indeed, one of the important lessons of the Grameen Bank is that appropriate procedures can be developed only after considerable experimentation, through a thorough understanding of the physical and socioeconomic environment.

APPENDIX: EXPENDITURE PATTERNS AND THE MARKET FOR NONFARM GOODS AND SERVICES

The Grameen Bank finances mostly small, nonfarm enterprises conducted on a self-employment basis. One of the issues that affects successful expansion of the bank is the nature of the market for nonfarm goods and services.

In Bangladesh the per capita income is so low that after meeting the most basic food needs, people have very little to spend on commodities and services produced in the nonfarm sector. The rural processing and manufacturing sector (cottage industry) has a special problem. It is argued that this sector serves the extreme poor, who for obvious economic reasons look for inexpensive products even if they are of low quality. As income increases, people tend to reject some products of cottage industries (often called dying industries) in favor of the better-quality output of formal industries located in urban areas. Thus it is foreseeable that with the expansion of credit facilities the market will be saturated with nonfarm goods and services, leading to a downward pressure on prices and profitability, which might limit expansion of these industries.

In the specific context of the Grameen Bank, it can be argued that the members have not yet faced this problem because the bank is still operating within a small area. The services of the bank have been extended to only about 6 percent of the villages in the country, so members do not have to depend on the local market. If it is saturated they can count on the wider national market by selling products in other areas that are not yet served by the bank. With nationwide expansion of the Grameen Bank, the competition among nonfarm activities would increase and borrowers would have to count more and more on their local markets.

The above proposition, however, takes a static view of the problem. First, agricultural growth and increases in farm productivity may expand the market for nonfarm goods and services more than proportionately through linkage effects. For Bangladesh, a number of recent studies show very high expenditure elasticity of demand for nonfarm goods and services and the majority of rural industry products.[79] Second, the Grameen Bank target group is about half the total population of the country. As their income increases, they could expand the market by demanding each other's products and services.

This appendix analyzes the expenditure pattern of borrower households and compares it with that of nonparticipants in order to clarify the above issue. It cannot be claimed that the information used for this analysis is accurate. The information on expenditures for basic food items was collected for the week preceding the 1985 field surveys, and the figures have been multiplied by 52 to get expenditures for the year. Thus the information would suffer from seasonal variations in expenditures. The information on expenditures for nonfood items like clothing, housing, medical expenses, and personal household effects was collected for fiscal year 1984/85 through a one-time survey and so may contain errors on account of memory recall. The expenditure pattern has been studied by estimating an Engel function of the following type on the cross-section data:

$$E_i = \alpha_i + \beta_i E + \gamma_i E \cdot \log E + \mu_i F + \lambda_i E \cdot F, \qquad (1)$$

where E is the per capita expenditure of

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[79] S. R. Osmani and N. C. Deb, "Demand for Products of Rural Industries," in *Bangladesh: Selected Issues in Employment and Development*, ed. R. Islam and M. Muqtada (New Delhi: International Labour Organisation, Asian Employment Program, 1986), pp. 151-167; and Hossain, "Agricultural Growth Linkages." pp. 1-30.

Table 49—Expenditure pattern for all sample households, 1984/85

Commodity Group	Average Budget Share	Marginal Budget Share	Expenditure Elasticity of Demand
	(percent)	(percent)	
Food	78.9	69.6	0.88
Cereals	51.3	36.1	0.70
Noncereal crops	9.5	11.5	1.21
Livestock and fisheries	9.6	11.1	1.15
Processed food	8.5	10.9	1.28
Manufactures	13.2	13.6	1.03
Cottage industry	7.7	8.5	1.10
Other industry	5.5	5.1	0.93
Services	8.0	16.8	2.10
Housing	4.0	10.8	2.68
Education	1.1	2.6	2.35
Health	2.1	3.1	1.48
Transport	0.8	0.5	0.56

Source: Estimated by fitting an Engel function on household data for 279 randomly selected households from five project villages and two control villages.

the household, E_i is the amount of expenditure on the ith commodity, and F is the number of persons in the household. This is a nonlinear function that allows for variation in the marginal budget share for the ith commodity, MBS_i, at different levels of income, which can be derived as follows:

$$MBS_i = \beta_i + \gamma_i(1 + \log E) + \lambda_i F. \quad (2)$$

To avoid the problem of heteroscedasticity, that the variability in E_i increases with the explanatory variable E, the function has been fitted in the following expenditure share form, which is obtained from (1):

$$S_i = \beta_i + \alpha_i/E + \gamma_i \log E + \mu_i \cdot F/E + \lambda_i F, \quad (3)$$

where $S_i = E_i/E$ is the share of the commodity in total expenditures.

The marginal budget shares and the expenditure elasticity of demand obtained from the estimated functions for all rural households are shown in Table 49. The results from separate estimates of the functions for different participant and nonparticipant groups are given in Table 50.

Cereal and noncereal crops are produced on farms that do not benefit from Grameen Bank loans. The average share of these commodities in the total household budget is nearly three-fifths, but as income increases, the budget share of these commodities (particularly of cereals) declines sharply. About 48 percent of the additional income is spent on these commodities and 52 percent on various nonfarm goods and services. The crops are produced mostly by the Grameen Bank nontarget group. They spent only 37 percent of their additional income on crop sector output and 63 percent on nonfarm goods and services. This shows that as agricultural income increases, the market for nonfarm goods and services expands more than proportionately. The commodities whose markets expand more than proportionately with the increase in farm household income are various rural services, cottage industry products, and processed agricultural goods.

The target-group nonparticipant households (those who own less than 0.5 acre of land but have not yet joined the bank) are the poorest among the three sample groups in Table 50. They spent 57 percent of their additional income on crop sector output and 43 percent on nonfarm goods and services. The corresponding estimates for Grameen Bank participants are 46 and 54 percent, respectively. Compared to nonparticipants the bank members spent proportionately

Table 50—Marginal budget shares and expenditure elasticity of demand for different groups of sample households, 1984/85

Commodity Group	Marginal Share of Budget			Expenditure Elasticity of Demand		
	Target Group			Target Group		
	Participant (N = 69)	Non-participant (N = 131)	Nontarget Group (N = 79)	Participant	Non-participant	Nontarget Group
	(percent)	(percent)	(percent)			
Food	67.1	80.4	59.4	0.86	0.99	0.79
Cereals	36.2	44.6	25.5	0.69	0.83	0.56
Noncereal crops	9.9	12.5	11.4	1.11	1.34	0.90
Livestock and fisheries	10.4	10.5	12.2	1.15	1.15	1.14
Processed food	10.6	12.8	10.3	1.33	1.46	1.22
(Purchased)	(25.7)	(45.1)	(34.1)	(0.89)	(1.40)	(1.17)
Manufactures	14.9	10.8	13.7	1.10	0.86	1.00
Cottage industry	9.4	6.7	9.2	1.27	0.95	1.10
Other industry	5.5	4.1	4.5	0.90	0.74	0.84
Services	18.0	8.8	26.9	2.20	1.47	2.41
Housing	12.8	4.5	17.1	2.53	1.80	3.05
Education	2.1	2.3	3.6	2.56	3.30	1.84
Health	2.0	2.1	5.2	1.19	1.10	1.90
Transport	1.2	. . .	1.0	1.80	. . .	1.20
Total	100.0[a]	100.0[a]	100.0	1.00	1.00	1.00

Source: Estimated by fitting an Engel function on household data.
Note: N is the size of the sample.
[a] Parts do not add to total because of rounding.

more on housing and cottage industry products. For members the expenditure elasticity of demand is more than one for livestock and fisheries, processed agricultural products, and cottage industry products. Thus, with increases in income, the members themselves expand the market for goods and services financed by Grameen Bank loans.

It is noted that rural processing and manufacturing output has higher expenditure elasticity than have urban industrial products, and their share of the marginal budget is also higher. Further analysis at the disaggregate commodity level (not reported) shows that this is mainly due to very strong demand for wooden furniture and fixtures (carpentry), cane and bamboo products, and mats. For handloom products, the expenditure elasticity is found to be close to unity, while the output of potters and blacksmiths (household utensils) has very low expenditure elasticity.

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THE BRAZILIAN WHEAT POLICY: ITS COSTS, BENEFITS, AND EFFECTS ON FOOD CONSUMPTION

Geraldo M. Calegar
G. Edward Schuh

May 1988

INTERNATIONAL
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FOREWORD

International Food Policy Research Institute (IFPRI) has a long record of research on various aspects of food subsidies in developing countries, including effects on consumption, production, and foreign trade. In addition to a number of research reports on countries including Brazil, India, Egypt, Bangladesh, Sri Lanka, and the Philippines, a series of working papers on food subsidies is in progress. This extensive body of work examines the social costs and benefits of subsidies from the viewpoint of nutrition, income levels and distribution, and equity between rich and poor and rural and urban, as well as fiscal costs. This large effort has been prompted by the critical importance of food prices to the real incomes of the poor, the large public costs of food subsidy programs, and the potential effects of these policies on food production.

This report on Brazil's wheat subsidies is particularly interesting because the government has intervened extensively in both production and consumption with often conflicting results. In doing so, it has inadvertently created severe strains on the economy that have had far-reaching results. By making available the results of studies such as this, IFPRI provides policymakers with information to choose wisely among the options for increasing agricultural production and feeding the poor, while avoiding the pitfalls that in the long run have high costs not only to efficiency but to equity as well.

John W. Mellor

Washington, D.C.
May 1988

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1

SUMMARY

Large government interventions in Brazil's wheat sector in recent years have raised questions about possible negative effects on resource allocation, expenditure on foreign exchange, and the drain on the public budget. This study is an attempt to identify and measure the main effects of these interventions on welfare, income distribution, and trade.

The two components of Brazilian wheat policy—production and consumption policies—are kept relatively separate. Both components derive from national goals of self-sufficiency in wheat supply, control of inflation, provision of low-cost food for the urban population, and improvement in the distribution of income. To implement its policies, the central government has become the only seller and buyer of both imported and domestically produced wheat. Moreover, the government has maintained rigid control over prices at the producer, wholesale, and retail levels.

This study attempts to estimate the aggregate effects of Brazilian wheat policy on domestic production, consumption, and imports, as well as its subsidy, social, and foreign exchange benefits and costs. It also estimates the effects of the wheat consumption policy on income distribution of a selected area in Brazil, comparing the effects with those of a similar policy for rice.

The basic analytical tools used are standard partial equilibrium and comparative static analyses, whenever necessary making use of the concepts of economic surplus. The first part of the analysis is made at the national level. The effects of production and consumption subsidies on the quantities produced, consumed, and imported, with and without interventions, are estimated, as are the welfare effects for producers, consumers, and for society as a whole during the period 1966-82.

In the second part of the analysis, which is based on disaggregated data, the effects of the consumption policy on the relative and absolute gains for consumers by expenditure group in the metropolitan area of Belo Horizonte and rural areas of the states of Minas Gerais and Espírito Santo are estimated for the year 1974/75.

During the period considered in this study, 1966-82, the Brazilian government made a sustained effort to achieve self-sufficiency in wheat through a production policy that consisted of a guaranteed producer price keyed to the cost of producing wheat. This producer price was generally above border prices evaluated at official exchange rates and below border prices evaluated at the shadow exchange rate. Compared with historical levels, wheat production would have been higher if the free market had prevailed at the shadow exchange rate in 4 years and lower in 13 others. The reason for this disparity is that the cruzeiro (Cr$) was persistently overvalued during this period. Hence, the producer subsidy in most cases only offset the tax resulting from a distorted exchange rate.

The wheat consumption policy, like the production policy, had two main components: an implicit subsidy to consumers resulting from the overvalued currency, and, mainly after 1972, an explicit general price subsidy. Throughout the period, aggregated wheat consumption increased mainly as a consequence of the explicit subsidy, and with the exception of seven years (1966-72), the increase in consumption was greater than the increase in wheat production, when evaluated at the official exchange rate. As a whole, the explicit production subsidy was able to reduce net imports only during the seven years referred to above. The gains in production were small, especially after discounting for the increase in seed demand for the following year in order to increase the area planted.

The wheat production policy for the whole period (1966-82) represented an estimated net subsidy of Cr$11.6 billion (in real 1977 cruzeiros), evaluated at the official exchange rate, and an estimated net tax of Cr$15.3 billion evaluated at the shadow exchange rate. This subsidy was due in part to the rise in the price of wheat in the world market in the mid- and late 1970s, at which time the domestic price set by the government fell short of the border price. In addition, the overvaluation of the cruzeiro represented a tax on producers.

The estimated social costs of the production policy for the whole period were Cr$2.1 billion and Cr$2.9 billion, evaluated at official and shadow exchange rates, respectively (again in real 1977 cruzeiros). The effects on foreign exchange induced by the production policy for the whole period were estimated to be a saving of about Cr$5.0 billion and an expenditure of Cr$16.4 billion. This latter expenditure in foreign exchange was contrary to the stated objective of the explicit production policy. Because of these failures, the wheat policy did not meet its stated objectives satisfactorily.

The total cost of the wheat consumption subsidy for the whole period was about Cr$84 billion at the official rate and Cr$150 billion at the shadow rate. Of this total, estimates show that consumers captured a maximum of 86 percent. However, because of spillover effects (approximately one-third of the total subsidy was captured by those outside of the target group), manipulations by the millers (another one-third) and social costs amounting to about 15 percent of the total cost of the subsidy, only 19 percent of the total subsidy during the period was captured by low-income consumers, the true target group. Thus, the cost-effectiveness of the wheat consumption subsidy is poor. This conclusion is reinforced by the results obtained from alternative consumption policy analysis, in which a general price subsidy for bread was ranked in third place and cost 4.5 to 7.4 times more than a food stamp program.

For foreign exchange expenditure, the wheat consumption subsidy program cost Cr$30 billion at the official exchange rate and Cr$54 billion at the shadow exchange rate. The expenditure was not in accord with one of the objectives of the wheat production policy, that of achieving a saving in foreign exchange. The combined effect of the production and consumption policies is the sum of the individual effects of each policy.

Even though the gains in consumer welfare are slightly biased toward high-expenditure groups, the disaggregative analysis shows that the wheat consumption subsidy contributed to the income redistribution objective by distributing the benefits of the subsidy equitably. When the same subsidy costs for wheat are shifted to rice in a simulated general price subsidy, the distribution of the gains is slightly biased toward the low-expenditure groups. However, two main points should be considered: first, even if a cut in the wheat consumption subsidy (or the simulated rice subsidy) harms the low- and medium-expenditure groups more, the decline in real expenditure is slight (less than 2 percent). Second, the nutritional effect in kilocalories consumed was small—less than 1.5 percent of the total per capita energy intake.

Finally, based on the cases studied in the alternative policy analysis, the wheat consumption subsidy is not an effective policy for redistributing income, nor for dealing with malnutrition problems. The alternative consumption policy analysis shows that if food consumption is to be subsidized, the subsidy should be through a target-oriented program, such as food stamps.

2

BRAZILIAN WHEAT POLICY

Both the production and consumption components of Brazilian wheat policy derive from a number of frequently articulated national goals: self-sufficiency in wheat supply, control of inflation, provision of cheap food for the urban population, and improvement in the distribution of income. To implement its policies, the central government has maintained both a monopolistic and a monopsonistic role in the wheat market, thus making it the only seller and buyer of both imported and domestically produced wheat. Moreover, the government has maintained rigid control over prices at the producer, wholesale, and retail levels.

This study has three main objectives: first, to estimate the total effect of Brazilian wheat policy on the levels of domestic production, consumption, and imports; second, to estimate aggregated subsidy, social, and foreign exchange costs, as well as the social benefits of the policy; and third, to estimate the income distribution effects of the wheat consumption policy for a selected area in Brazil, comparing them with those of a similar policy for rice.

The first part of this chapter deals with production policy, emphasizing the reasons for the chosen policy of self-sufficiency. The second part deals with consumption policy and speculates on the reasons for its particular form. At the end of each part, some questions are raised that should be of interest to policymakers.

Wheat Production Policy

The production side of Brazilian wheat policy has a fairly long history. Wheat was introduced in Brazil in the first quarter of the sixteenth century by the first European settlers. Prior to the mid-1930s, however, there is no indication that the wheat crop ever developed sufficiently to satisfy domestic demand. Because of the absence of a guaranteed market for domestically produced wheat, farmers in the southern states of Brazil (Rio Grande do Sul and Santa Catarina) had little incentive to increase wheat production beyond the amount required to satisfy their own needs. Thus there was little surplus to be marketed. In the mid-1930s the government established a chain of experimental stations to develop production technologies suitable to Brazilian conditions. However, cultivated area and production remained relatively small until 1967 (Table 1), reflecting the high cost of production, poor soils, serious disease problems, difficult climatic conditions, and inadequate scientific and technical support.

Starting in about 1967, cultivated area and production began to increase at a fairly rapid rate, reaching record highs in area in 1979 and in production in 1976 (Table 1). As a whole, however, production has been relatively unstable, primarily because of climatic conditions and diseases, which have made wheat production a somewhat risky activity. Since wheat is an off-season (winter) crop in Brazil, it seldom conflicts with the main in-season (summer) crop, soybeans. The machinery, labor, and some chemical inputs applied to wheat are complementary with soybean production. On the negative side, however, the chronologies of the two crops do not fit perfectly. Soybean production can be reduced about 6 percent, on average, by the delay in planting caused by waiting for the wheat harvest. In the northern part of the states of Paraná, São Paulo, and Mato Grosso, the overlap period is in the fall, when the soybean harvest delays wheat planting.

Because of the risks associated with the production of wheat and the penalty to soybean yields when double-cropped with wheat, there is a large annual variation in

Table 1—Cultivated area, production, and average yields of wheat, 1962-82

Year	Area	Production	Yield
	(hectares)	(metric tons)	(kilograms/ hectare)
1962	258,221	255,404	989
1963	302,122	97,811	324
1964	300,542	213,691	711
1965	354,680	221,576	625
1966	385,028	298,523	775
1967	561,987	364,870	649
1968	845,693	693,598	820
1969	1,299,518	1,146,319	882
1970	1,861,204	1,734,972	932
1971	2,008,215	2,038,632	1,015
1972	2,340,431	693,399	296
1973	1,604,305	1,934,439	1,206
1974	2,212,643	2,848,040	1,287
1975	3,110,830	1,582,587	509
1976	3,520,709	3,037,864	863
1977	3,020,831	2,012,842	666
1978	2,794,365	2,700,707	966
1979	4,104,144	2,881,186	702
1980	3,318,501	2,702,130	814
1981	2,063,747	2,223,632	1,077
1982	2,960,010	1,802,337	609

Sources: Banco do Brasil, "Trigo Nacional," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, December 1979 (mimeographed); and Banco do Brasil, "Preços de Trigo para os Produtores e Volume de Produção," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, 1983 (mimeographed).

area planted to wheat as individual farmers adjust their planting to changing conditions. In recent years the area planted in soybeans has increased more rapidly than the area planted in wheat, as some farmers have opted to plant soybeans alone rather than risk a potential failure in the wheat crop. After 1972, the area in soybeans increased faster than that in wheat, and in 1980, 8.6 million hectares were planted to soybeans, whereas only 3.3 million hectares were planted to wheat.

The few alternatives to wheat in the winter season include pasture, oats, flax, and rapeseed. Pasture requires an associated livestock enterprise and is not a viable alternative for all soybean producers. Oats and flax have limited markets. Rapeseed is a new crop being tested at the experimental station level. If viable, it would have a market similar to soybeans with possible application as a substitute for diesel oil.

Guaranteed producer prices have been used to stimulate domestic production of wheat ever since 1938. In recent years the producer price has been set by the National Supply Council (CONAB) and made public by the National Supply Superintendency (SUNAB) through reports of deliberations known as *portarias.* Domestic production is purchased by the Bank of Brazil according to rules designed to avoid frauds, such as those that have occurred in the past. These frauds gave rise to such concepts as "paper wheat" and "wheat nationalization."

Both kinds of fraud had their roots in a dual price system. Because of the production subsidy built into the guaranteed producer price, the price of domestically produced wheat was above the world free market price, while the price of imported wheat was below the free market price because of the implicit consumption subsidy that resulted from a more favorable exchange rate for wheat imports. The "paper wheat" fraud was of two types. The first consisted of an agreement between miller and producer for a pseudo purchase of national wheat, which gave the miller the right to acquire a corresponding quota of the cheaper imported wheat. The second type appeared after Government Decree Number 40,316 of November 8, 1956, which determined that the price of domestically produced wheat consisted of two parts, one paid by the miller at the moment of purchase from the producer, and the other paid by the Bank of Brazil when the producer presented the receipt of sale. With this system it became only a matter of acquiring a receipt of sale for quantities greater than were actually sold, or even nonexistent sales, in order to profit.

The "wheat nationalization" fraud consisted of taking the low-priced wheat imported by the miller through the quota system and following it back to the farmer, from where it returned "nationalized" as being produced domestically at a cost of almost twice that of the imported wheat. Thus, in order to profit through either of these frauds one had only to know how to manipulate the bureaucratic mechanisms.

In order to put an end to these frauds, on November 9, 1962, the government approved a resolution that named the Bank of Brazil as the only direct buyer of domestically produced wheat.[1] As a consequence of the earlier fraud schemes, data on domestic wheat collected prior to 1962, the date of the government resolution, are not considered reliable. Since 1962 these frauds have occurred less frequently.

Self-sufficiency in wheat production has been a policy goal pursued by the government for a long time, primarily through a producer price policy that guarantees prices above world market prices. In addition, however, considerable resources have been provided for the development of marketing facilities. These facilities include cooperatives for supplying inputs, the Bank of Brazil for purchasing the output, and the Brazilian Storage Company (CIBRAZEM) for storing and distributing the production to mills throughout the country.

The main arguments used to justify the goal of self-sufficiency can be grouped in three basic categories—economic, political, and romantic.[2] The economic category includes three arguments. The first, based on foreign exchange considerations, argues that wheat imports consume valuable foreign exchange that should be reserved for importing goods more essential to Brazil's growth.[3] A second argument is that many resources have already been invested in machinery, marketing structures, and other kinds of human and physical capital, and that these investments, as well as the people who depend on them, should not be abandoned because the resources involved are not perfectly mobile. The third argument is that foreign countries, including some of Brazil's major suppliers, subsidize wheat production, and therefore Brazilian producers must be subsidized if they are to compete with foreign exports.

In an attempt to evaluate these arguments, Knight noted that "the main economic argument is that wheat production should not be rapidly reduced, because this policy would involve a waste of resources already committed to wheat or wheat-soybean production, as well as considerable social costs. No valid economic arguments exist, however, for increasing wheat production further until research and extension have drastically altered the efficiency with which resources can be employed in this activity."[4]

Since it is not possible to justify the self-sufficiency policy followed by the government in terms of short-run economic efficiency, one might go further and think in terms of long-run efficiency along the lines of an "infant industry" argument. On these grounds, increasing production over time would be expected either to drive production costs down or give rise to some positive externalities.

Data on the evolution of production costs for wheat over time, however, indicate that they have almost always been equal to the price guaranteed by the government for the respective year.[5] Moreover, with few exceptions, the guaranteed price, calculated at the official exchange rate, from 1967 through 1982 was almost always above world prices. The exceptions were 1973-74 and 1980, when world prices were above domestic producer prices because of a large increase in world wheat prices (Table 2). The infant

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[1] For details see Ricardo Pereira Soares, *Avaliação Econômica da Politica Triticola de 1967 a 1977,* vol. 20. (Brasília: Comissão de Financiamento da Produção, Coleção Análise e Pesquisa, 1980); and Peter Knight, *Brazilian Agricultural Technology and Trade—A Study of Five Commodities* (New York: Praeger, 1971), p. 223.

[2] These arguments were set forth in Knight, *Brazilian Agricultural Technology.*

[3] This has been the basis of much of Brazil's more general import-substituting posture.

[4] Knight, *Brazilian Agricultural Technology.*

[5] Fereração das Cooperativas Brasileiras de Trigo e Soja LTDA, "Custo de Produção: Trigo Revisão Safra, 1983, Soja-Estimativa, 1983-84," Pôrto Allegre, Rio Grande do Sul, 1983; and World Bank, *Brazil: A Review of Agricultural Policies* (Washington, D.C.: World Bank, 1982).

Table 2—Estimated real prices at the producer, miller, and border levels for wheat, 1965-82

Year	Producer Price	Index	Miller Price	Index	Border Price	Index
	(1977 Cr$/ metric ton)	(1965 = 100)	(1977 Cr$/ metric ton)	(1965 = 100)	(1977 Cr$/ metric ton)	(1965 = 100)
1965	3,577	100	2,707	100	3,888	100
1966	3,246	91	2,222	82	3,941	101
1967	3,170	89	2,096	77	3,998	103
1968	3,141	88	2,116	78	3,533	91
1969	3,107	87	2,006	74	3,321	85
1970	2,955	83	2,161	80	2,950	76
1971	2,955	77	2,036	75	2,728	70
1972	2,587	72	1,950	72	2,828	73
1973	2,736	76	1,897	70	4,042	104
1974	3,838	107	1,838	68	5,806	149
1975	3,389	95	1,480	55	4,180	108
1976	3,012	84	1,093	40	3,742	96
1977	3,398	95	1,202	44	2,496	64
1978	3,251	91	1,032	38	2,807	72
1979	2,498	70	732	27	3,103	80
1980	2,424	68	516	19	3,594	92
1981	2,929	82	1,105	41	3,338	86
1982	3,123	87	1,364	50	2,979	77

Source: Calculated by the authors.

Notes: The producer price is the farmgate price adjusted to the mill level. The miller price is the price set by the government, including the consumer subsidy. The border price is the c.i.f. price plus the port-to-mill expenses, using the shadow exchange rate to convert the c.i.f. prices to the domestic currency.

industry argument, therefore, does not appear to be relevant.

To evaluate the foreign exchange savings argument, one can take as a criterion the domestic resource cost of a U.S.$1.00 saving in wheat imports. Previous studies have found that coefficient to be 2.20 for 1967, 2.47 for 1968, 2.00 for 1971, and 1.35 for 1976/77.[6] This means that it cost at least U.S.$1.35 in domestic resources to save U.S.$1.00 in wheat imports, and in some years it cost significantly more.

These data suggest that the production subsidy has not only driven a wedge between domestic and world price, but it may also be worsening the foreign exchange situation. That would be the case if resources were being attracted to the production of wheat at the expense of some other exports that would be socially profitable in terms of generating foreign exchange.

The political arguments favoring domestic wheat production are based on the supposed value of economic autarky. One such argument is that in case of a world war the country might be strongly penalized by its high wheat consumption and the need to depend heavily on imports. A second argument is that countries that supply a large part of these imports might impose economic pressures on Brazil. A third is that there is always the possibility of a large rise in wheat prices in the world market, such as occurred in the mid-1970s, and that paying these prices might create political difficulties at home.

Regarding these political reasons for subsidizing domestic wheat production,

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[6] Coefficients for 1967 and 1968 are from Knight, *Brazilian Agricultural Technology;* those for 1971 are from José Roberto Mendonça de Barros, "Exportações de Produtos Primários Não Tradicionais," Série IPE Monografias 4, Universidade de São Paulo, 1974, p. 97; and those for 1976/77 are from Pereira Soares, Avaliação Econômica da Política Triticola.

Knight noted that "it should be remembered, however, in weighing these essentially noneconomic arguments, that wheat is not indispensable, and that the production of many low-cost substitutes could be rapidly increased in the event of a future emergency."[7]

The romantic reasons for pursuing the domestic production of wheat are the least important of the three broad sets of arguments set forth above and will not be considered here.[8]

Few studies have attempted to evaluate the real and monetary effects of the wheat production policy over time.[9] But because of current high rates of inflation, the government has recently been forced to cut expenditures in order to balance the budget. As a consequence, questions have been raised about all kinds of subsidies. In the case of wheat subsidies, policymakers would benefit from answers to the following questions: What has been the total treasury cost of the programs? What have been the gains in producers' welfare? What have been the social costs of the subsidies? What have been the savings or losses in foreign exchange? And, what has been the real increase in production due to the subsidies? This study will attempt to provide answers to these questions.

Wheat Consumption Policy

The consumption side of Brazilian wheat policy has a more recent history, even though wheat, in the form of French bread, macaroni, and wheat flour, has been a staple in the consumer's food basket ever since colonial days. Only since 1972, however, when an explicit systematic general consumption subsidy was instituted, has the per capita consumption of wheat shown a clear tendency to increase (Table 3). This subsidy has been a major factor in impeding the attainment of self-sufficiency in wheat production, especially after 1972, because it contributed strongly to keeping the ratio of domestic production to consumption low (Table 4). As a result, imports have supplied an average of approximately 70 percent of domestic consumption in the last 17 years.

Wheat is the major food item imported in Brazil. Both consumption and imports have had a clear tendency to increase over time, with a peak reached for both values in 1980. The value of wheat imports as a share of total value of imports tended downward prior to 1971, but since then it has fluctuated around 3 to 4 percent, in large part because of the consumption subsidy.

According to Luis Eduardo Carvalho, the main reason for providing an explicit consumption subsidy in the period after 1972 was to reduce domestic price inflation, and specifically to escape the effects of the increases in the world price of wheat in the mid-1970s.[10] Concern was also expressed about maintaining the nutritional status of low-income groups. The subsidy was instituted in the expectation that the world price of wheat would soon return to the low levels that prevailed before the increase. But real wheat prices (1967 = 100) did not return to the old levels of U.S.$60-U.S.$70 per metric ton that prevailed in the late 1960s and early 1970s.[11] Instead, the price of wheat rose to U.S.$148 in 1974, went to U.S.$61 in 1977 and to U.S.$71 in 1978, and rose again to U.S.$90 in 1980 and to U.S.$81 in 1981.

The effects of consumption subsidies on inflation are not as straightforward as proponents of such subsidies seem to believe. In a narrow sense, such subsidies can lower

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[7] Knight, *Brazilian Agricultural Technology.*

[8] Ibid.

[9] See Claudio Roberto Contador, "Trigo Nacional: O Custo Social da Auto-Suficiência," *Estudos Econômicos* 4 (No. 3, 1974): 53-83; Pereira Soares, *Avaliação Econômica da Política Triticola;* and Knight, *Brazilian Agricultural Technology.*

[10] Luis Eduardo Carvalho, "O Caráter Social de Política de Subsídio ao Trigo," *Alimentação e Nutrição* (March 1981): 32-42.

[11] All tons referred to in this report are metric tons.

Table 3—Annual per capita consumption of wheat, rice, and beans, 1966-81

Year	Wheat	Rice	Beans
		(kilograms)	
1966	29.2	43.6	23.4
1967	27.9	45.8	27.2
1968	32.3	45.9	24.6
1969	32.0	41.8	21.7
1970	32.6	47.8	21.5
1971	33.6	42.9	25.7
1972	34.5	48.9	24.9
1973	37.9	43.2	20.2
1974	40.0	40.7	19.4
1975	42.1	42.3	19.4
1976	46.9	52.1	15.0
1977	47.5	48.5	19.4
1978	49.9	40.0	17.4
1979	52.5	45.2	. . .
1980	57.1	47.0	. . .
1981	50.0	50.4	. . .

Sources: Data on wheat consumption are from Brazil, National Supply Superintendency, Departamento do Trigo, "Evolução do Preço do Trigo em Grão para Produtores e Moinhos e Consumo Aparente de Farinha de Trigo," SUNAB, Rio de Janeiro, 1983 (mimeographed); data on population are from Banco Central, *Brasil Programa Econômico: Ajustamento Interno e Externo,* October 1982; and data on rice and beans are from Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years).

the cost of living of particular groups in society. Moreover, wheat products are heavily weighted in the calculation of the general price index. As computed by the Getúlio Vargas Foundation, the General Price Index (IGP-DI) is a weighted average of wholesale prices (0.6), the consumer price index in Rio de Janeiro City (0.3), and the civil construction cost index in Rio de Janeiro (0.1). (The latter was replaced in 1985 by a National Civil Construction Cost Index with the same weight of 0.1.)[12] The wheat and wheat products included in the Wholesale Price Index (IPA-DI) are as follows:

	Weights
Wheat	1.2229
Wheat flour	0.4347
Total	1.6576

Those in the Consumer Price Index in Rio de Janeiro (IPC-RJ) are

	Weights
Wheat flour	0.0756
French bread	3.1819
Subtotal	3.2575
Sandwich loaf	0.2111
Noodles *(massas)*	1.5988
Cakes	0.1571
Cookies	0.3155
Subtotal	2.2825
Total	5.5400

Thus, the total weight for wheat and wheat flour in the IPA-DI corresponds to 0.994690 in the IGP-DI. If the wheat flour and French bread from the IPC-RJ (3.2575 · 0.3 = 0.9773) are added to that, the wheat and wheat products in the IGP-DI will correspond to at least 1.9719 percent of total weight. The other items in the IPC-RJ listed above, including wheat products and others such as maize products, correspond to a weight of 0.684 percent in total IGP-DI. Thus, wheat products correspond to at least 1.9719 percent and, at most, 2.6567 percent of the total weight of the IGP-DI.[13] Hence, on the surface, such subsidies would appear to contribute to reducing measured inflation. However, their government costs contribute to the budget deficit and, consequently, are a general cause of inflation, as has been shown in Egypt[14] and Pakistan.[15]

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[12] Getúlio Vargas Foundation, "General Price Index."

[13] José L. Carvalho, personal communication, Rio de Janeiro, May 13, 1986.

[14] Grant M. Scobie, *Food Subsidies in Egypt: Their Impact on Foreign Exchange and Trade,* Research Report 40 (Washington, D.C.: International Food Policy Research Institute, 1983).

[15] F. D. McCarthy and Lance Taylor, "Macro Food Policy Planning: A General Equilibrium Model for Pakistan," *Review of Economics and Statistics* 62 (February 1980): 107-121.

Table 4—Consumption and imports of wheat grain and selected ratios, 1966-82

Year	Consumption A	Imports B	Relative Shares		
			(B/A) · 100	(C/A) · 100	(D/E) · 100
	(1,000 metric tons)				
1966	2,448	2,394	98	8	10.5
1967	2,404	2,446	102	10	10.8
1968	2,884	2,621	91	10	7.6
1969	2,908	2,356	81	20	6.6
1970	3,034	1,969	65	32	4.1
1971	3,209	1,711	53	47	3.3
1972	3,378	1,797	53	56	5.1
1973	3,798	2,946	76	12	4.6
1974	4,116	2,399	58	40	3.3
1975	4,437	2,082	47	56	3.9
1976	5,064	3,426	68	25	3.4
1977	5,252	2,608	50	51	2.5
1978	5,656	4,334	77	27	3.8
1979	6,097	3,651	60	38	3.4
1980	6,802	4,755	70	38	3.7
1981	6,098	4,360	72	38	3.2
1982	6,101	4,144	68	30	3.1

Sources: For consumption data: Brazil, National Supply Superintendency, Departamento do Trigo, "Evolução do Preço do Trigo em Grão para Produtores e Moinhos e Consumo Aparente de Farinha de Trigo," SUNAB, Rio de Janeiro, 1983 (mimeographed); for import data, Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years); Banco do Brasil, "Trigo Nacional," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, 1979; and Fundação Getúlio Vargas, *Conjunctura Econômica*, various issues.

Notes: A = consumption,
B = imports,
C = $(\text{production}_{t-1} - \text{seeds}_t)$,
D = f.o.b. value of wheat imports, and
E = f.o.b. value of all Brazilian imports.

Telma Ferreira e Silva[16] estimated that, as of November 1980, a reduction of the consumption subsidy by 25, 50, and 100 percent would have increased the general price index by 0.57, 1.14, and 2.27 percent, respectively, other things being equal.[17] If one recognizes that during 1980 the inflation rate in Brazil was 110 percent, then it would appear to make little difference, except in a distributional sense, to have an inflation rate 2.27 percent higher by cutting the entire wheat consumption subsidy. Since the effect on the measured rate of inflation of eliminating the subsidy would not be great, and it would have only a one-time effect, then the question remains, "Why doesn't the government eliminate it?" The answer to this question leads to the other major reason for maintaining the consumption subsidy—that the subsidy is supposedly relevant to lowering the price of wheat products to benefit low-income groups who are heavily dependent on those products.

Few studies have been made of this issue.[18] Those that have been made, however, have suggested that the subsidy has benefited medium- and high-income groups more than low-income groups.

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[16] Telma Ferreira e Silva, "Política Triticola—Efeitos de uma Redução no Subsídio" (M.S. thesis, Universidade Federal de Viçosa, 1981).

[17] Discussion of inflation in Brazil usually focuses on the cost of living *(custo de vida)*.

[18] See Ferreira e Silva, "Política Triticola"; L. E. Carvalho, "Caráter Social de Política de Subsídio ao Trigo"; and Cheryl Williamson Gray, *Food Consumption Parameters for Brazil and Their Application to Food Policy,* Research Report 32 (Washington, D.C.: International Food Policy Research Institute, 1982).

At least two issues of interest arise relevant to the consumption subsidy for wheat. First, this subsidy has in fact benefited mostly medium- and high-income groups in society because those groups (all those above 2X in Table 5) consume more of the three major wheat products than the low-income groups (X-2X in Table 5). Moreover, on a regional basis, the poorer northeast, north, and center-west regions have benefited less from the subsidy than the more developed south and southeast regions (Table 6). This is because the former regions have lower per capita consumption rates than do the latter, even though per capita consumption has increased substantially in the poorer regions since 1972.

Despite the bias of the subsidy in favor of medium- and high-income groups, it is important to note that low-income families spend a larger share of their budget on wheat products (5-6 percent) than do medium- and high-income families (about 1 percent). Thus, in a relative sense a price increase for these products would have a larger relative effect on low-income families, in a situation in which about 72 percent of the economically active population receives only 25 percent of all income.[19]

A second issue is that the consumption subsidy has distorted the relative prices between wheat products and rice, beans, maize flour, and cassava flour, making wheat products relatively cheaper (Table 7) and stimulating their consumption (Table 5). As a consequence of the subsidy, the producers of rice, beans, maize, and cassava, who are usually poor small farmers, have suffered discrimination.

To the authors' knowledge, there have been no previous studies of these two important issues that have attempted to estimate

Table 5—Per capita consumption of wheat by level of expenditure, 1974/75

City	Wheat Product	Average	X	1X – 2X	2X – 4X	4X – 8X	8X – 12X	12X – 20X	20X – 28X	More than 28X
						(grams/person/day)				
Rio de Janeiro	Bread	80	45	67	83	91	91	81	77	73
	Macaroni	19	22	21	19	19	16	12	12	16
	Flour	4	1	2	3	6	7	8	13	10
São Paulo	Bread	73	32	60	74	78	83	81	72	62
	Macaroni	18	13	14	17	19	24	19	19	18
	Flour	6	2	3	4	6	9	13	12	16
Pôrto Alegre	Bread	102	67	90	102	111	104	111	93	101
	Macaroni	15	11	13	16	15	15	10	10	18
	Flour	28	38	35	34	23	18	13	19	13
Distrito Federal	Bread	73	28	52	70	81	87	91	89	84
	Macaroni	13	4	9	13	15	15	15	10	13
	Flour	4	0	1	2	4	6	9	7	13
Belem	Bread	101	69	86	104	121	110	116	109	116
	Macaroni	11	3	7	12	16	16	14	13	16
	Flour	2	0	1	1	3	4	3	6	5

Source: Luis Eduardo Carvalho, "O Caráter Social de Política de Subsídio ao Trigo," *Alimentação e Nutrição* (March 1981): 32-42.

Note: X = a minimum monthly salary per family plus 0.22 of that salary.

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[19] L. E. Carvalho, "Caráter Social de Política de Subsídio ao Trigo."

Table 6—Total and per capita consumption of wheat by region, 1972 and 1981

Region	Total Consumption 1972	Total Consumption 1981	Percent Change	Per Capita Consumption 1972	Per Capita Consumption 1981	Percent Change
	(metric tons/year)			(kilograms/year)		
Northeast	654,273 (19.0)	1,302,833 (20.7)	99	22.0	37.5	70
Southeast	1,992,703 (57.7)	3,368,399 (53.5)	69	49.4	71.9	46
South	667,594 (19.4)	1,312,557 (20.8)	97	40.0	69.1	73
North	80,727 (2.3)	183,508 (2.9)	127	22.1	30.8	39
Center-West	54,703 (1.6)	132,703 (2.1)	143	10.6	17.6	66
Total	3,450,000 (100.0)	6,300,000 (100.0)	83	35.0	55.3	58

Source: Luis Eduardo Carvalho, "O Caráter Social de Política de Subsídio ao Trigo," *Alimentação e Nutrição* (March 1981): 32-42.
Note: Numbers in parentheses represent the share of the total.

Table 7—Retail price of wheat flour relative to prices of rice, beans, cassava flour, and maize flour, 1966-82

Year	$\frac{Pwf}{Pr}$	$\frac{Pwf}{Pb}$	$\frac{Pwf}{Pcf}$	$\frac{Pwf}{Pmf}$
1966	0.88	0.83	2.00	. . .
1967	0.69	1.20	1.69	1.85
1968	1.00	1.26	1.93	2.20
1969	1.04	0.73	2.06	2.05
1970	1.17	0.85	1.85	1.85
1971	0.99	0.87	1.45	1.83
1972	0.82	0.88	1.35	1.65
1973	0.90	0.42	1.49	1.59
1974	0.73	0.63	1.40	1.42
1975	0.52	0.53	0.94	0.98[a]
1976	0.50	0.20	0.50	0.83[a]
1977	0.60	0.26	0.65	1.06[a]
1978	0.46	0.38	0.75	0.85[a]
1979	0.35	0.22	0.60	0.75[a]
1980	0.28	0.13	0.43	0.62[a]
1981	0.49[a]	0.21[a]	0.53[b]	0.92[a]
1982	0.36[a]	0.36[a]	0.73[a]	1.40[a]

Source: Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years).
Notes: P is price; wf, wheat flour; r, rice; b, beans; cf, cassava flour; and mf, maize flour.
[a] Average for city of São Paulo.
[b] Average for city of Fortaleza.

the treasury, social, and foreign exchange costs or the consumer benefits of the consumption subsidy for wheat, or their relative incidence among income groups. Only one study has attempted to evaluate the alternative products to which the wheat subsidy could be changed in order to diminish the spillover effects.[20] That study did not address the issues listed above.

The government has been urged to phase out these subsidies, especially in light of the drain on the budget. However, given economic, social, and political considerations, it has been difficult to do this. In 1980, the government initiated a plan to remove the consumption subsidy gradually, but at the time of this writing it is still high. Moreover, with current high rates of unemployment, and with the economy in disarray, policymakers could benefit from information on both the real and monetary effects of the subsidies, and on possible lower-cost alternatives to wheat consumption subsidy that would help low-income groups.

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[20] Williamson Gray, *Food Consumption Parameters for Brazil.*

3

ANALYSIS OF THE AGGREGATE EFFECTS OF WHEAT POLICY ON PRODUCERS AND CONSUMERS

This chapter deals with the basic model used to develop the aggregative analysis of the wheat consumption and production policies and the discussions of the main results.

A Model for the Aggregative Analysis

Price policy for the Brazilian wheat sector is implemented by means of a multiple price system. The price for producers is set by the government, generally at levels above world market prices or the price at which wheat can be imported. The difference between these two prices constitutes the producer subsidy.

The consumer price is the price at which the government sells the wheat to millers. This price has, in general, been below the world price. The difference between these prices is the consumption subsidy.

Figure 1 presents this multiple price system graphically. SS, DD, and WW are the domestic supply, domestic demand, and world (export) supply of wheat to Brazil, respectively. The world (export) supply to Brazil is assumed to be perfectly elastic, which means that Brazil is assumed to be a price taker in the world market. This is a plausible assumption because Brazil is a relatively small buyer in the world market, taking an average of only 3.6 percent of total world exports.[21]

Standard partial equilibrium and comparative static analysis, which makes use of the concepts of economic surplus is used as the basic analytical tool in this study. Since the literature on this approach to policy analysis is rather large, the justifications for and limitations of the approach will not be addressed here.[22]

The following measures for evaluating the production policy can be derived from Figure 1:

TCP = treasury cost of the production policy subsidy (area a + b), (1)

CPW = change in producers' welfare (area a), (2)

SCP = social costs in production (area b), (3)

FEP = foreign exchange effect on production (area e + i), and (4)

CQP = change in quantity produced $(Q_p - q_p)$, (5)

where

Q_p = quantity produced at the subsidized price, and

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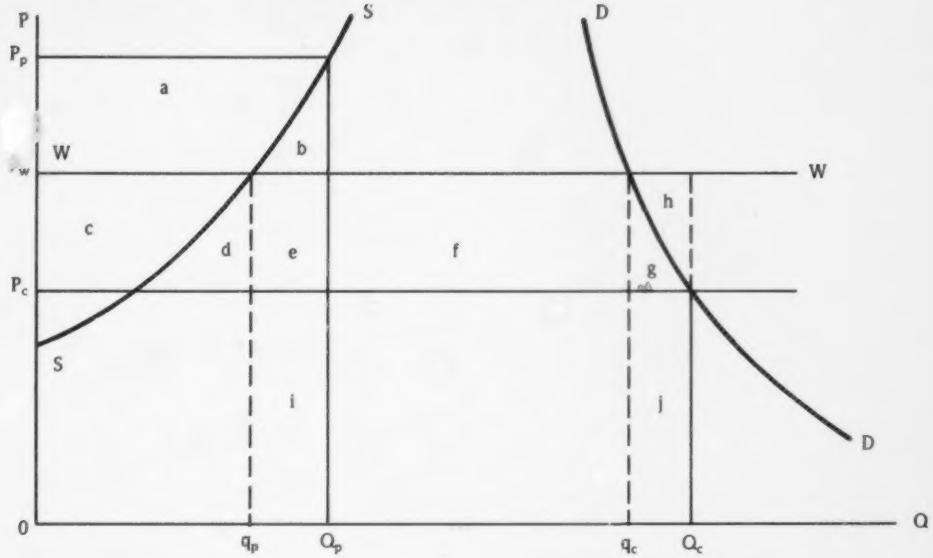
[21] D. Portela de Lima Fernandes, "Aspectos Econômicos e Estatísticos do Trigo no Brasil," *Informe Agropecuário* 9 (January 1983): 1-8.

[22] Background information can be found in J. M. Curry, J. A. Murphy, and A. Schmitz, "The Concept of Economic Surplus and Its Use in Economic Analysis," *Economic Journal* 81 (December 1971): 741-799; and R. E. Just, D. L. Hueth, and A. Schmitz, *Applied Welfare Economics and Public Policy* (Englewood Cliffs, N.J.: Prentice-Hall, 1982). An application along the lines sought here can be found in Randolph Barker and Yujiro Hayami, "Price Support Versus Input Subsidy for Food Self-Sufficiency in Developing Countries," *American Journal of Agricultural Economics* 63 (February 1981): 8-21.

Figure 1—Multiple price system for wheat



q_p = quantity produced at the world price.

Assuming a constant elasticity supply curve such as $q = aP^{\varepsilon}$, equations (1-5) can be rewritten as

$$TCP = (P_p - P_w)Q_p\ , \tag{6}$$

$$CPW = \int_{P_w}^{P_p} aP^{\varepsilon}dP = [Q_p/(1+\varepsilon)]\,[P_p - (P_w/P_p)^{\varepsilon}P_w]\ , \tag{7}$$

$$SCP = TCP - CPW\ , \tag{8}$$

$$FEP = P_wQ_p[1 - (P_w/P_p)^{\varepsilon}]\ , \text{ and} \tag{9}$$

$$CQP = Q_p[1 - (P_w/P_p)^{\varepsilon}]\ , \tag{10}$$

where

$P_p = [(P_f + m_a) \cdot 100]/GPI$,

$P_w = [(P_{cif} \cdot ER + m_b) \cdot 100]/GPI$,

and

P_p = producer price adjusted to the wholesale level,

P_f = the farmgate price,

P_w = the border price adjusted to the wholesale level,

P_{cif} = the c.i.f. price,

ER = the equilibrium exchange rate,

GPI = the general price index,

m_a = the farm-to-mill expenses,

m_b = the port-to-mill expenses,

ε = the domestic supply elasticity, and

a = the supply shifter.

To evaluate the consumption policy, one can derive the following measures from Figure 1:

TCC = treasury cost of the consumption policy subsidy [area (c + d + e + f + g + h)], (11) CCW = change in consumers' welfare [area $(c + d + e + f + g)$], (12)

SCC = social cost of consumption policy (area h), (13)

FEC = foreign exchange effect on the consumption side [area $(h + g + j)$],(14)

and

CQC = change in quantity consumed $(Q_c - q_c)$, (15)

where

Q_c = quantity consumed at the subsidized price, and

q_c = quantity consumed at the world price.

Assuming a constant elasticity demand curve, such as $q = bp^{-\eta}$, one can rewrite equations (11-15) as

$$TCC = (P_w - P_c)Q_c, \qquad (16)$$

$$CCW = \int_{P_c}^{P_w} bP^{-\eta}\,dP = [Q_c/(1-\eta)]\,[(P_c/P_w)^{\eta}P_w - P_c]\,, \qquad (17)$$

$$SCC = TCC - CCW, \qquad (18)$$

$$FEC = P_w Q_c[1 - (P_c/P_w)^{\eta}], \text{ and} \qquad (19)$$

$$CQC = Q_c[1 - (P_c/P_w)^{\eta}]\,, \qquad (20)$$

where P_c is the consumer price; η, the domestic demand elasticity; and b, the demand shifters.

Finally, the net effects of both the wheat production policy and the wheat consumption policy can be summarized as

$$TTC = TCP + TCC, \qquad (21)$$

$$CSW = CPW + CCW, \qquad (22)$$

$$TSC = SCP + SCC, \qquad (23)$$

$$NEF = FEP + FEC, \text{ and} \qquad (24)$$

$$CI_t = CQC_t - [CQP_{t-1} - (SP_t - SW_t)],^{23} \qquad (25)$$

where

TTC = the total treasury cost,

CSW = the change in social welfare,

TSC = total social cost,

NEF = net effect on foreign exchange,

CI_t = change in imports of wheat in year t,

SP_t = quantity of seeds used in year t at the subsidized producer price,

SW_t = quantity of seeds used in year t if the world price had prevailed, and

CQP_{t-1} = change in quantity produced in year t−1.

The determination of the three main prices to be used in the analysis just described (P_f, P_c, and P_w) involves two main mechanisms: government intervention (P_f and P_c) and free market forces (P_w). In the first semester of each year, before the planting season, the government, through the National Supply Superintendency (SUNAB), makes public the wheat producer price for the year. The political and economic forces involved in the determination of the producer price include the two big cooperatives of wheat and soybean producers in the states of Rio Grande do Sul (FECOTRIGO) and Paraná (OCEPAR), and the government institutions—the Commission for Production Financing (CFP), the Ministry of Agriculture, and the Ministry of Planning—through their bureaucratic and political forces. Basically, these institutions start the bargaining process with estimates of the cost of production for wheat during the year, and from that, they consider other aspects such as self-sufficiency goals.

The determination of miller prices (P_c) during the year is primarily a result of the

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[23] The expression $[CQP_{t-1} - (SP_t - SW_t)]$ represents the net change in production in year t−1 available for human consumption in year t after adjustment for seeds used in year t.

willingness of the government to have a cheap food policy, for reasons that are not clear, at least on the surface. Some argue that because wheat products are an important component of the consumer price index, then any time the government wants a lower inflation rate for a specific month, it only has to leave the wheat price unaltered. However, this argument should be embraced with caution.

Other than the exchange rate policy followed during the period, there is little government interference in the determination of the import price (P_w); it is determined in the world market. As a rule, the exchange rate policy has been to maintain an overvalued currency in order to subsidize imports, especially capital goods, for the industrialization of the country. This exchange rate policy also works as an implicit import subsidy for wheat, however, thus keeping P_w artificially low domestically.

The nominal rate of protection for producers (NPP) and the nominal rate of protection for consumers (NPC) are used as measures of price distortion that result from government intervention. They are calculated as percentages of the world or border prices, as follows:

$$NPP = [(P_p - P_w)/P_w] \cdot 100, \text{and} \qquad (26)$$

$$NPC = [(P_w - P_c)/P_w] \cdot 100. \qquad (27)$$

The border prices are calculated using the shadow or official exchange rate for each year and "correcting" for 1977 cruzeiros (Cr$) at the wholesale level, taking into account the respective marketing margins. Producer prices are also measured at the wholesale level in 1977 cruzeiros by taking into account the respective marketing margins.

As Bale and Lutz point out, the use of wholesale prices can be justified in a practical sense because wheat grain is transformed into various products between the wholesale and retail levels.[24] As a consequence, a single retail price does not exist for wheat grain.

Given the unavailability of data on stocks, the levels of stocks will be assumed to remain constant and unchanged.

All the data needed for application of the model are reported in Appendix 1, Tables 16 to 18.

Behavior of Real Prices and Estimated Nominal Rates of Protection

Estimates of the real prices of wheat at the producer, miller, and border prices are presented in Table 2. Producer prices are farmgate prices adjusted to the mill level; miller prices are the prices set by the government, and include the consumer subsidy; and border prices are the c.i.f. prices evaluated with the shadow foreign exchange rate (SER) and adjusted to the miller level, exclusive of the consumer subsidy.

Prices at the miller level declined almost steadily until 1980 (Figure 2), when the lowest price for the period was observed: Cr$516, which was only 19 percent of the highest price of Cr$2,707, in 1965, which was arbitrarily taken as a base of comparison (see Table 2). To understand this trend, it is useful to divide the series into two distinct periods: the first covering the period up to 1972, and the second covering 1973-82. Prior to 1972, the tendency of miller prices to decline in real terms was mainly caused by the downward trend in world prices, represented here by border prices. From 1973 through 1980, the downward trend in miller prices was largely a consequence of the explicit general wheat price consumption subsidy. In 1982, however, a government plan to phase out gradually the wheat consumption subsidy was introduced.

During the same two periods, producer prices experienced rather different trends. From a peak in 1965, the real price at the

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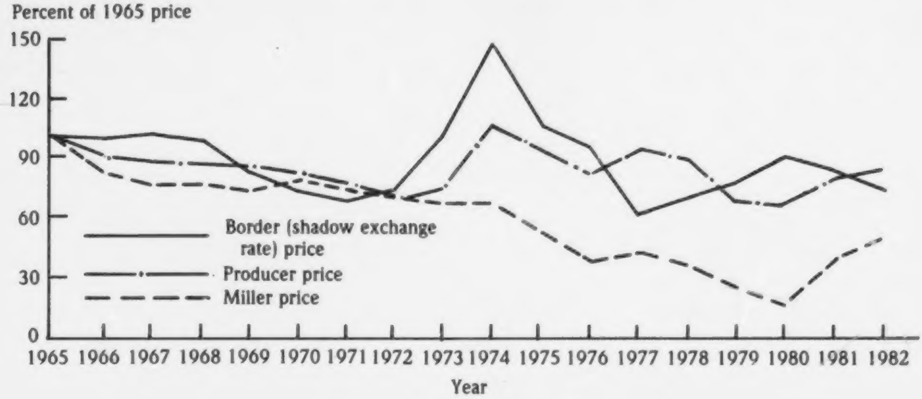
[24] M. D. Bale and E. Lutz, "Price Distortions in Agriculture and Their Effects: An International Comparison," *American Journal of Agricultural Economics* 63 (February 1981): 8-22.

Figure 2—Behavior of real prices of wheat, 1965-82



producer level declined through 1972 (Figure 2). The observed decline was primarily a result of year-to-year variations in the level of the producer subsidy set by the government. From 1972 through 1982, the pattern of producer prices varied. From 1972 until 1974, they showed a recovery in real terms over 1972. This recovery could be associated with high world prices from 1973 to 1976. The government seems to have followed world prices in setting its guaranteed prices to producers until 1976. From 1976 through 1982, the producer price had a slight tendency to decline. There were two cycles, one beginning in 1976 and the other in 1980.

Finally, border prices tended to decline from 1967 until 1971, following the behavior that had prevailed since the late 1940s.[25] After 1971, border prices experienced a cyclical pattern with two peaks (Figure 2), one in 1974 and another in 1980. Both of these peaks were caused in part by crop failures in the Soviet Union, but also by monetary phenomena in international commodity markets.

The production and consumption subsidies, calculated as a percentage of the border price evaluated at both the official and the shadow exchange rates, are shown in Appendix 1, Table 19 and represented in Figure 3. At the official exchange rate (OER), the production subsidy was positive in 15 years of the period and negative in 3 years. In the years in which the production subsidy was negative, the producers were in fact taxed. This occurred because the border price happened to be far above the guaranteed price set by the government for the domestic producers. The guaranteed price generally has been set at the end of the first semester of each year.

Under the OER, the government pursued a consistent policy of import substitution on the production side until 1982, except for the years 1973, 1974, and 1980, for which the guaranteed producer prices fell short of the border prices.

At least two facts help explain this behavior: first, the instability in the world wheat market, reflected in the rises and declines in border prices after 1972; and, second, the overvaluation of the cruzeiro with respect to the U.S. dollar. As can be seen in Figure 3, when the production subsidy is calculated using the OER, producers were taxed in only three years, 1973, 1974, and 1980, and in two of those years border prices were at their peak. However, when the

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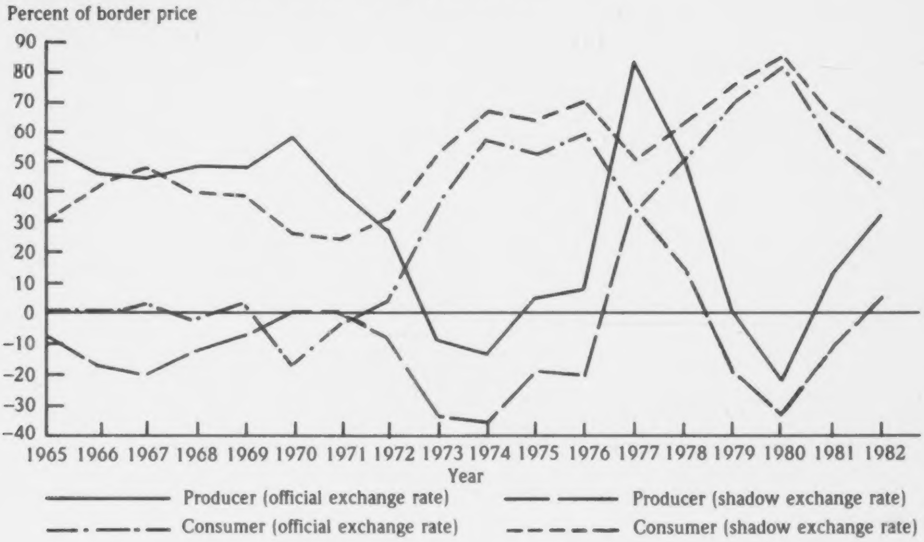
[25] M. V. Martin and R. F. Brokken, "The Scarcity Syndrome: A Comment," *American Journal of Agricultural Economics* 65 (February 1983): 158-159.

Figure 3—Subsidy levels for wheat, 1965-82



overvaluation of the cruzeiro is taken into account, producers are perceived to receive a lower subsidy. This is because the overvalued currency served as an implicit (export) tax for producers, since it caused domestic prices to be lower than they would have been without the overvaluation.

On the consumption side, the subsidy was mainly an implicit subsidy until 1972, due primarily to the overvaluation of the cruzeiro (Appendix 1, Table 19 and Figure 3). An overvalued currency is an implicit (import) subsidy for consumers because it causes domestic prices to be lower than they would have been without the overvaluation.

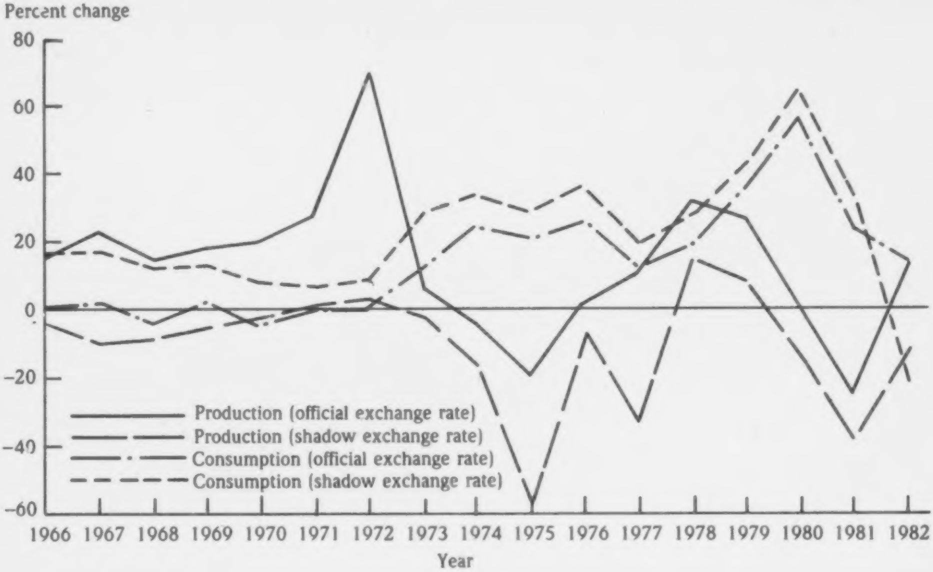
Because of an upturn in the world prices of wheat in 1971 and the end of purchases on concessionary terms from the United States under P.L. 480, the government subsidized wheat consumption explicitly every year from 1972 through 1982. It should be noted that at the OER, it appears that consumers were explicitly taxed during three years of the 1965-71 period. This apparent tax stems from the policy vis-à-vis concessional food purchases, in which wheat was purchased under the concessionary terms of P. L. 480, below world prices and with long-term financing. It was sold in the domestic market at higher prices in order to obtain revenue to finance the wheat subsidy for producers. Of course, this apparent tax disappears when the distortion in the exchange rate is excluded.

Production, Consumption, and Import Effects

Results of the model are presented first under the OER and then under the SER.

Estimates of the effects of the production subsidy or tax on the levels of production under the OER are presented in Appendix 1, Table 20, and represented in Figure 4. As can be seen, the changes in production are positive or negative and vary according to the magnitudes of the producer and border prices and the output level for the respective year. The change in production as a percentage of the level of production that would have resulted if border prices had prevailed was never greater than 31.2 percent, except for the year 1972, when it was 71.1 percent. In three years production was in fact reduced, 1973, 1974, and 1980.

Figure 4—Production and consumption effects of the wheat subsidy, 1966-82



The changes in consumption as a consequence of the consumption subsidy were positive and varied according to the level of consumer and border prices and the consumption level of the respective year. The largest relative change in consumption was in 1980 when the consumption subsidy was at its highest level, 85.6 percent (Table 2, last column) and total consumption was at its highest level, 6.8 million metric tons (Appendix 1, Table 17). In 1980 the total consumption of wheat grain was 56.3 percent higher than it would have been if there had been no consumption subsidy at all (Appendix 1, Table 20, column 7). In evaluating the trade effects of the policies, it is of interest to determine the separate effects of the production policies. These are identified as the change in production and the partial change in import levels shown in Table 20, second and fourth columns, respectively.

The total effect on imports (taking into account both producer and consumer policies) was negative and small during 1966-72, indicating that the wheat production policy had a relatively small effect on self-sufficiency in wheat production. This was so because of the large increase in wheat imports that resulted from the wheat consumption subsidy, especially after 1972.

This is a good example of conflicting policy objectives. On the one hand, the production policy was designed to substitute for wheat imports, while, on the other hand, the consumption policy, although not necessarily designed to stimulate wheat consumption, in fact did so, and this in turn required more imports. Thus, the effect of the wheat production policy, as an import substitution policy, was partially or totally overridden by the consumption policy and the distortion in the exchange rate.

To isolate the effects that overvaluation of the cruzeiro had on the results of Table 20 in Appendix 1, the figures in that table are recalculated using the SER. The results are presented in Appendix 1, Table 21. The production policy has a smaller effect when the distortion in the exchange rate is taken into account. This is because domestic production at world prices would have been larger and the observed production would continue to be the same. On the other hand, the consumption policy has a larger effect on consumption when the distortion in the exchange rate is taken into account. Finally, the total change in imports is larger than when the overvaluation of the currency is not taken into account, mainly as a result of the wheat consumption subsidy. Thus the overvaluation of the cruzeiro works as a deterrent to the import substitution policy.

The effects of production and consumption policies, with and without distortions in the exchange rate, are estimated in Appendix 1, Tables 22-25.

Cost, Benefits, and Exchange Rate Effects

The cost, benefits, and exchange rate effects of the Brazilian wheat policy can be viewed, considering not only the explicit but also the implicit subsidy or tax placed on domestic producers and consumers of wheat products, through the price of wheat set periodically by the government and through the existing exchange rate policy.

A summary of the measurements of the effects for the period of 1966-82 is represented in Table 8. One can see that at the outset, producers and consumers were both explicitly subsidized. However, when the effect of the overvaluation of the currency (the SER)during the period was included, it is clear that producers were taxed and consumers were highly subsidized in a net sense. This was so because an overvalued currency works as an export tax for producers and as an import subsidy for consumers.

The gains in welfare for producers, consumers, and both groups combined ranged from 81-86 percent of the total subsidy value. Under the SER, only producers experienced a loss in welfare. The social cost of the Brazilian wheat policy ranged from 14-19 percent of the total subsidy value, which shows how large the costs of such government interventions can be. The foreign exchange effects of the Brazilian wheat policy were negative in all cases except for the production policy analyzed under the OER.

If it is assumed that one of the major objectives of the wheat production policy is to promote import substitution of wheat, then it can be argued that such a government intervention did not work accordingly in a free market situation. Finally, each dollar of foreign exchange saved or spent due to the wheat production policy has a social cost ranging from 0.17 to 0.43, which means that in order to substitute US$1.00 of wheat imports the government had to spend from US$1.17 to US$1.43 (Table 8

Table 8—Isolated and combined total monetary effects of the Brazilian wheat policy, 1966-82

Exchange Rate	Total Subsidy (Tax) Cost	Change in Welfare as Percent of Total Cost	Social Cost as Percent of Total Cost	Foreign Exchange Effect	Social Cost/ Foreign Exchange
	(U.S. $ million)			(U.S. $ million)	
Production policy					
Shadow	−803.4	−119	19	−865.6	−0.17
Official	820.1	82	18	351.0	0.43
Consumption policy					
Shadow	7,890.2	85	15	−2,847.2	−0.41
Official	5,937.6	86	14	−2,103.0	−0.39
Combined production and consumption policies					
Shadow	7,086.8	81	19	−3,712.8	−0.36
Official	6,757.7	86	14	−1,752.0	−0.54

Source: Calculated by the authors using the total results of Appendix 1, Tables 23-25, and the shadow and official exchange rates for 1977 taken from Appendix 1, Table 18. The minus sign indicates a loss in foreign exchange.

first two lines). (Note that the interpretation of social cost does not depend on whether the sign is negative or positive.) As a whole, each additional US$1.00 of wheat imports had a cost ranging from US$1.36 to US$1.54 (Table 8, fifth and sixth lines of the last column). All these results indicate that the Brazilian wheat policy has been a sizable burden for society as a whole, and in the case of wheat production policy, it cannot be justified as an import substitution policy, because in a free market situation wheat imports tend to increase due to implicit taxation of producers as a result of an overvalued exchange rate.

Figures 5-8 show the behavior of costs, benefits, and foreign exchange effects of both wheat consumption and wheat produc-

Figure 5—Effects of the wheat consumption policy under the official exchange rate, 1966-82

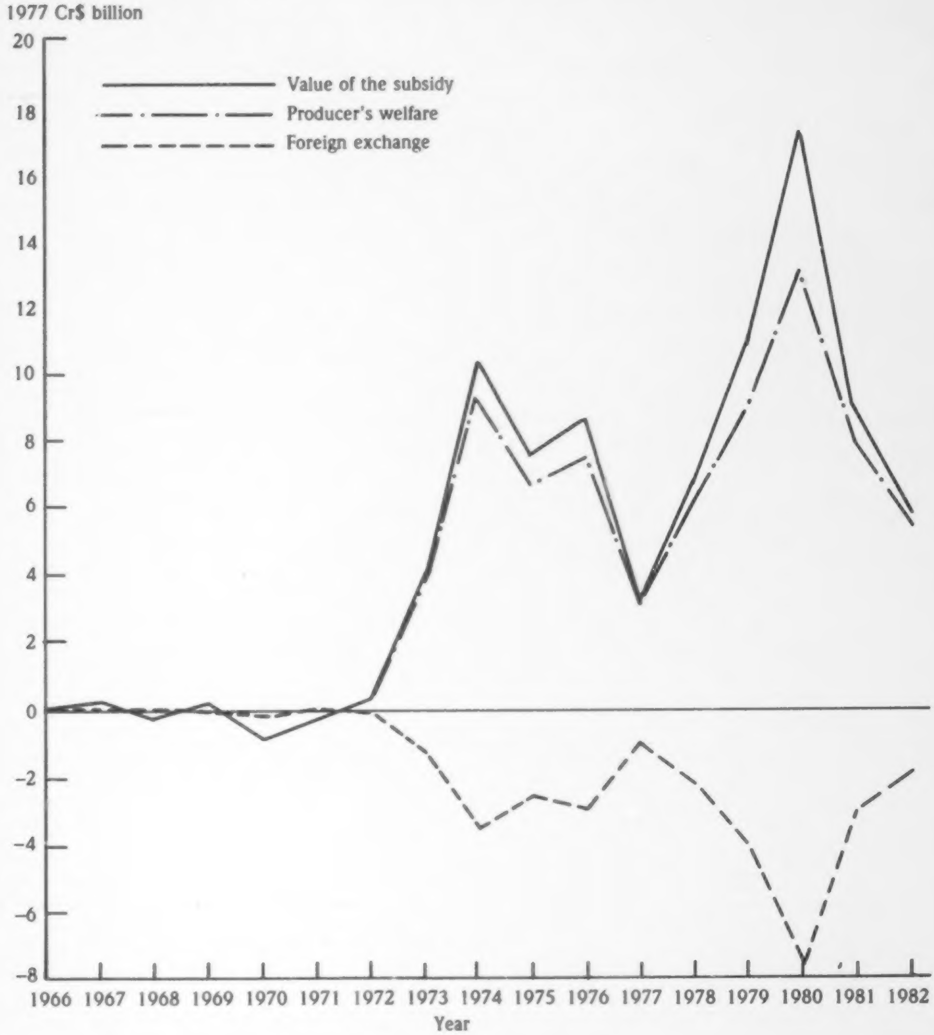


Figure 6—Effects of the wheat consumption policy under the shadow exchange rate, 1966-82

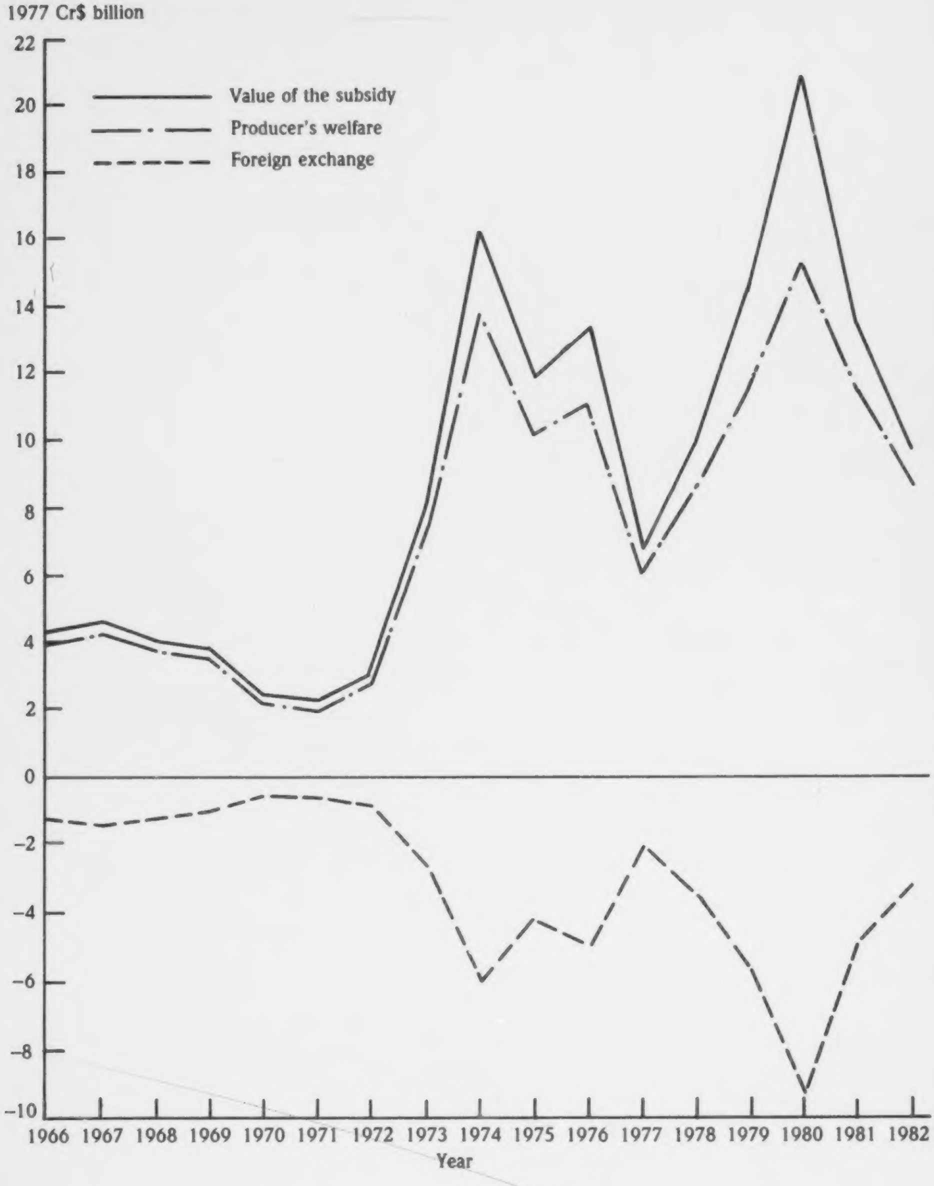


Figure 7—Effects of the wheat production policy under the official exchange rate, 1966-82

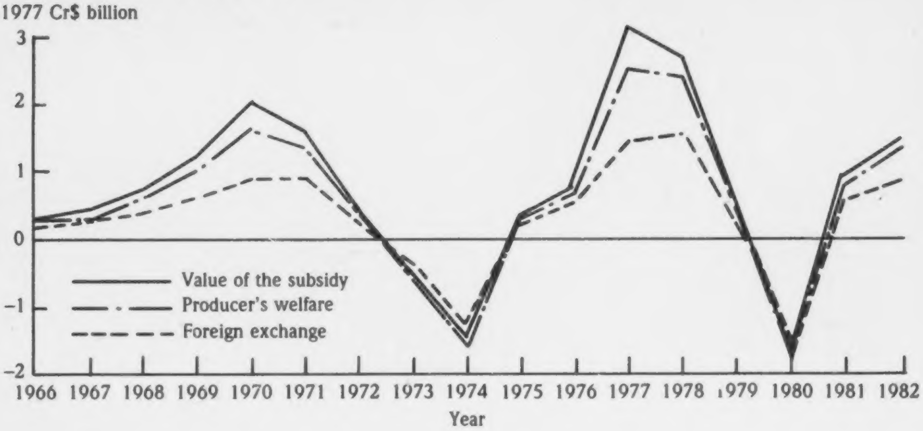
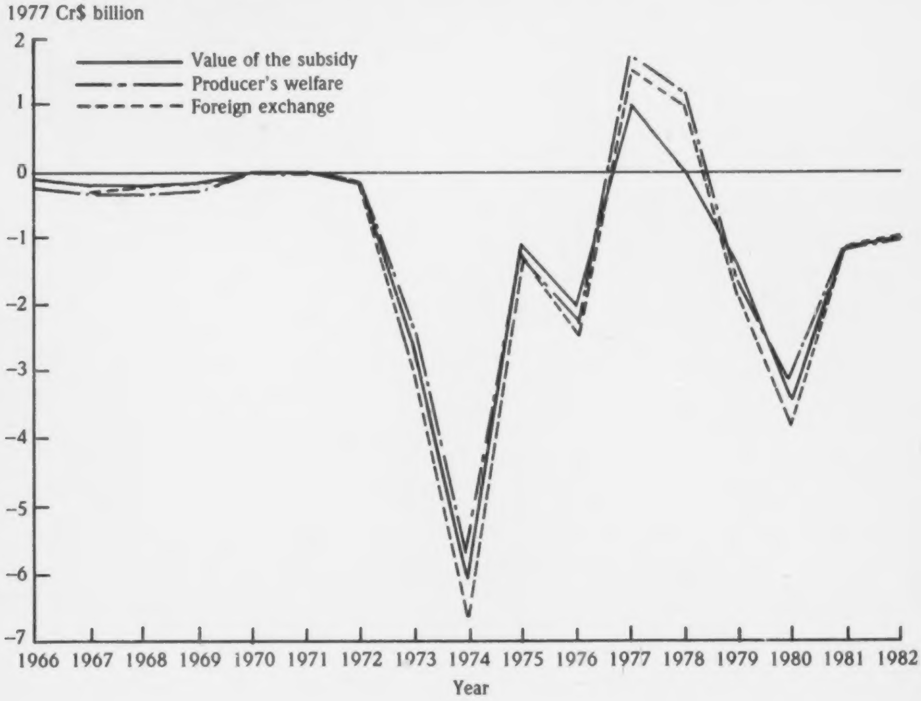


Figure 8—Effects of the wheat production policy under the shadow exchange rate, 1966-82



tion policy for the period 1966-82, under official and shadow exchange rates, respectively. The wheat consumption policy had two distinct subperiods—the first from 1966 to 1972 and the second from 1972 to 1982 (Figures 5 and 6). In the first subperiod, the effects of that policy on the value of the subsidy, producers' welfare, and foreign exchange were small under the OER (Figure 5) and of considerable size under the SER (Figure 6). In the second subperiod, under both OER and SER, the sizes of the policy measures referred to were considerably larger, mainly as a result of the explicit wheat consumption subsidy in effect since 1973. Both the wheat consumption subsidy and the expenditures in foreign exchange reached their maximums in 1980. This is because domestic production was not large enough to meet the domestic demand under the subsidized price.

The wheat production policy had different subperiods of subsidization and taxation of producers during the period of the analysis under both the OER and the SER (see Figures 7 and 8). Under the OER, producers were subsidized until 1972 and again from 1975 to 1979 and from 1981 to 1982. They were taxed during 1973, 1974, and 1980. Under the SER, producers were taxed during most of the period, the exceptions being 1970-71 and 1977-78.

4

DISTRIBUTION OF BENEFITS BY FARM SIZE AND INCOME

Brazilian wheat policy has two basic income distribution effects. The first is at an aggregate level, in which case the issue is the distribution of the implicit and explicit taxes and subsidies between producers and consumers. That issue was considered in the previous section. The second effect is at a disaggregate level, in which case the issue is the distribution of benefits among producers and consumers by size of farm and by level of income.

In this chapter, this second effect is examined. The distributive effects on consumers are emphasized because the consumption policy seems to involve a larger redistribution of income than does the production policy, for two basic reasons. First, total subsidy costs of the wheat consumption policy are larger than those of the production policy, and, second, the whole population of the country consumes wheat products, but, as a rule, wheat is only grown on medium and large farms in the southern part of Brazil. An additional reason for concentrating on the consumption policy is that more consumption data are available for such an analysis, including data on expenditure and consumption of wheat products by expenditure group. Parallel data on the distribution of wheat production by farm size are not available.[26]

A Model for Disaggregative Analysis

The model used to carry out the disaggregative analysis (which applies only to the consumption policy) is similar to that used for the aggregative analysis. The main difference is that the aggregate result here is made up of the sum of the consumers' surplus of all expenditure groups for each wheat product.

The case for one wheat product j and two expenditure strata (i = 1,2) is shown in Figure 9. The first two parts of the figure represent alternative expenditure situations and the third part depicts the aggregate market. D_{j1} and D_{j2} represent the respective disaggregate and aggregate demand curves for the particular wheat product, with the aggregate curve of D_j being the horizontal sum of the disaggregate curve of Figure 9. P_0^j and P_1^j, q_0^{ji} and q_1^{ji}, and Q_0^j and Q_1^j are the prices and quantities, with and without price subsidy, respectively, for the wheat product j. Then, using procedures similar to those for the aggregative analysis, policy measures can be derived by using the areas a_i, b_i, c_i, and f_i.

Assuming a constant elasticity demand curve of the form $q_{ji} = a_{ji}\ P - \eta_{ji}$ for each wheat product j and each expenditure stratum i, and generalizing for n expenditure strata and m wheat products, one can derive the following formulas to conduct the disaggregative analysis for a specific year:

$$\begin{aligned} TCC &= \sum_{j=1}^{m} \sum_{i=1}^{n} TCC_{ji} \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} (P_1^j - P_0^j)\, q_0^{ji}, \qquad (28) \end{aligned}$$

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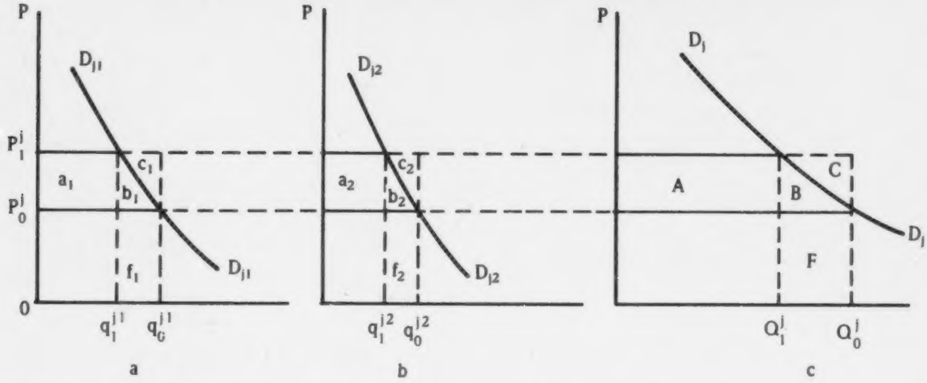
[26] In a study of the effect of the distortion in the exchange rate by size of farm for Brazil as a whole, Mauro Lopes found that taxation by overvaluation of the cruzeiro had a regressive effect on income distribution. Large producers can escape the export tax by reorganizing their resources, but this option is not available to the small producers (Mauro R. Lopes, "The Mobilization of Resources from Agriculture: A Policy Analysis of Brazil" [Ph.D. dissertation, Purdue University, 1977]).

Figure 9—Hypothetical market for a specific wheat product under two income strata situations and for the aggregated market



Notes: a and b represent alternative income strata; c represents the aggregated demand.

$$\begin{aligned} CCW &= \sum_{j=1}^{m} \sum_{i=1}^{n} CCW_{ji} \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} \int_{P_0^j}^{P_1^j} a_{ji} P^{-\eta_{ji}} dp \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} [q_0^i/(1 - \eta_{ji})] \\ &\quad [(P_0^j/P_1^j)^{\eta_{ji}} P_1^j - P_0^j], \end{aligned} \tag{29}$$

$$\begin{aligned} SCC &= TCC - CCW \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} SCC_{ji}, \text{ and} \end{aligned} \tag{30}$$

$$\begin{aligned} CQC &= \sum_{j=1}^{m} \sum_{i=1}^{n} CQC_{ji} \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} q^{ji}[1 - (P_0^j/P_1^j)^{\eta_{ji}}], \end{aligned} \tag{31}$$

where

TCC = the total treasury cost on the consumption side for a specific wheat product,

CCW = the change in consumers' welfare,

SCC = the social cost of the subsidy,

CQC = the change in quantity consumed, and

η_{ji} = the constant demand elasticity for wheat product j in each expenditure strata i, where j = 1,2,... m i = 1,2,... n.

P_0^j and P_1^j are the prices of the specific wheat product j with and without the consumption subsidy, respectively, and a_{ji} is the demand shifter for each product j in each expenditure stratum i.

To estimate P_0^j and P_1^j the following formulas can be used:

$$P_0^{wf} = P_{wg} \cdot Q_{wg} + 0_c^{wf}, \tag{32}$$

$$P_1^{wf} = [P_{wg}/(1 - CS_{wg})]Q_{wg} + 0_c^{wf}, \tag{33}$$

$$P_0^j = P_0^{wf} Q_{wf}^j + 0_c^j, \quad \text{and} \tag{34}$$

$$P_1^j = P_1^{wf} Q_{wf}^j + 0_c^j, \tag{35}$$

where

P_k^{wf} = the price of wheat flour with the consumption subsidy, k = 0, and without the consumption subsidy, k = 1;

P_{wg} = the price of wheat grain for the millers;

Q_{wg} = the quantity of wheat grain required to produce 1 kilogram of wheat flour;

0_c^{wf} = other costs involved in the production of wheat flour;

CS_{wg} = the percent value of the average consumption subsidy calculated for a respective year from the aggregative analysis;

P_i^j = the price of wheat product j with the wheat consumption subsidy, k = 0, and without the consumption subsidy, k = 1;

Q_{wf}^j = the quantity of wheat flour required to produce 1 kilogram of the jth wheat product; and

0_c^j = other costs involved in the production of the jth wheat product.

P_0^{wf}, P_{wg}, Q_{wg}, CS_{wg}, P_0^j, and Q_{wf}^j are known from secondary sources; 0_c^{wf} and P_0^{wf} can be calculated from equations (32) and (33); and O_c^j and P_i^j can be determined by substituting them in equations (34) and (35).

After calculating the change in consumers' welfare by expenditure strata, one can go further and derive the respective Lorenz curve for the distribution of the gain in consumers' welfare and compare that distribution with the Lorenz curve resulting from the expenditure distribution of the families in the respective expenditure groups.[27] The relative bias of the wheat consumption subsidy with respect to low- or high-income consumers can then be evaluated.

General Considerations

As a basis for the discussion of the disaggregate effects of the consumption policy on consumers from different expenditure groups, the data set collected by Fundação Instituto Brasileiro de Geografia e Estatística (FIBGE), from now on referred to as the FIBGE survey, and some direct price elasticities estimated by Garcia are examined.[28] Two main considerations are emphasized. The first is the effect of the consumption subsidy on consumers' expenditures on wheat products, and the second is its effect on calorie consumption. In both cases, a specific region of Brazil is considered—Region 4 of the FIBGE survey, which encompasses the states of Minas Gerais and Espírito Santo. Within this region, data on the metropolitan area of Belo Horizonte represent the urban area of Minas Gerais and data on the states of Minas Gerais and Espírito Santo represent the rural area.

For each region of the FIBGE survey total expenditures and consumption of wheat products are almost invariably correlated positively with the total expenditures of the family by expenditure group. This positive correlation indicates that the higher the expenditure group, the greater the absolute benefits captured by the consumers in those groups. The discrepancies in per capita expenditure on wheat products (Table 9), per capita wheat consumption (Table 10), and the estimated per capita wheat consumption subsidy (Table 11) are mainly due to the price differential resulting from differences in composition or quality of the wheat products consumed by each group of consumers in each expenditure group. On the other hand, in the urban area of Belo Horizonte, the budget share of wheat products is inversely correlated with total expenditure by expenditure group. This suggests that, in relative terms, the lower expenditure groups could gain more from the consumption subsidy than the higher expenditure groups.

Thus, for the urban area any decline in the consumption subsidy could lead to a decline in real income because there are few close substitutes for wheat products. An increase in the price of those products means that, on a limited budget, there will

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[27] For details on the Lorenz curve theory, see Nanak C. Kakwani, *Income Inequality and Poverty—Methods of Estimation and Policy Applications* (New York: Oxford University Press for the World Bank, 1980), p. 377.

[28] Fundação Instituto Brasileiro de Geografia e Estatistica, *Annuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years); João Carlos Garcia, "Avaliação dos Impactos do Aumento na Oferta de Alimentos e Renda sobre a Nutrição Humana e suas Implicações para o Estabelecimento de Prioridades de Pesquisas Agrícolas no Brasil" (Ph.D. dissertation, Universidade Federal de Viçosa, 1978).

Table 9—Annual expenditures and budget shares per capita, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75

Household Expenditure Group	Average Annual Per Capita Expenditure	Wheat Products[a] Per Capita Expenditure	Wheat Products[a] Budget Share	Rice Per Capita Expenditure	Rice Budget Share	Beans Per Capita Expenditure	Beans Budget Share	Cassava Flour Per Capita Expenditure	Cassava Flour Budget Share	Maize Per Capita Expenditure	Maize Budget Share
(Cr $)		(Cr $)	(percent)	(Cr $)	(percent)	(Cr $)	(percent)	(Cr $)	(percent)	(Cr $)	(percent)
Metropolitan area											
Less than 4,500	1,604	56	3.5	70	4.4	44	2.7	15	0.9	13	0.8
4,500–8,999	1,749	57	3.3	105	6.0	51	2.9	13	0.7	14	0.8
9,000–11,299	2,549	86	3.4	154	6.0	60	2.4	19	0.7	14	0.5
11,300–15,799	2,692	87	3.2	144	5.3	53	2.0	9	0.3	12	0.4
15,800–22,599	3,793	111	2.9	164	4.3	63	1.7	15	0.4	12	0.3
22,600–31,599	4,453	122	2.7	143	3.2	54	1.2	10	0.2	10	0.2
31,600–45,199	5,919	143	2.4	132	2.2	50	0.8	9	0.2	10	0.2
45,200–67,799	10,869	182	1.7	154	1.4	60	0.5	12	0.1	9	0.1
More than 67,999	27,494	229	0.8	131	0.5	51	0.2	25	0.1	16	0.1
Mean	6,755	123	1.8	140	2.1	54	0.8	13	0.2	12	0.2
Rural area											
Less than 2,300	530	9	1.6	39	7.3	46	8.6	21	3.9	14	2.6
2,300–3,399	955	19	2.0	77	8.1	70	7.3	28	2.9	39	4.1
3,400–4,499	991	21	2.1	93	9.4	65	6.5	20	2.0	36	3.7
4,500–6,799	1,123	28	2.5	112	10.0	69	6.1	22	2.0	38	3.4
6,800–8,999	1,574	39	2.5	159	10.1	88	5.6	23	1.4	48	3.0
9,000–15,799	1,690	42	2.5	163	9.7	79	4.7	14	0.8	48	2.8
15,800–22,599	2,670	60	2.3	190	7.1	91	3.4	19	0.7	54	2.0
22,600–31,599	3,778	67	1.8	221	5.8	84	2.2	17	0.4	55	0.6
More than 31,599	7,863	104	1.3	265	3.4	98	1.2	20	0.3	43	0.6
Mean	2,268	48	2.1	172	7.6	87	3.9	21	0.9	50	2.2

Source: Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional da Despesa Familiar: Despesas das Famílias, Dados Preliminares,* 6 vols. (Rio de Janeiro: FIBGE, 1978 and 1979).

[a] Wheat products include wheat bread, macaroni, and wheat flour.

Table 10—Per capita energy consumption per day, by expenditure group, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75

Household Expenditure Group	Total Kilo-calories per Day	Wheat Products[a]		Rice		Beans		Cassava Flour		Maize	
		Kilo-calories per Day	Percent of Total	Kilo-calories per Day	Percent of Total	Kilo-calories per Day	Percent of Total	Kilo-calories per Day	Percent of Total	Kilo-calories per Day	Percent of Total
(Cr $)											
Metropolitan area											
Less than 4,500	1,457	189	13.0	274	18.8	152	10.4	28	1.9	122	8.4
4,500–8,999	1,824	196	10.7	435	23.8	187	10.3	21	1.2	94	5.2
9,000–11,299	1,852	236	12.7	465	25.0	169	9.1	22	1.2	68	3.7
11,300–15,799	1,903	247	13.0	470	24.7	161	8.5	12	0.6	66	3.5
15,800–22,599	1,933	257	13.3	475	24.6	161	8.3	16	0.8	57	2.9
22,600–31,599	2,027	297	14.7	453	22.3	154	7.6	12	0.6	52	2.6
51,600–45,199	2,138	339	15.9	412	19.3	136	6.4	14	0.7	41	1.9
45,200–67,799	2,170	338	15.6	386	17.8	129	5.9	11	0.5	32	1.5
More than 67,799	2,323	356	15.3	321	13.8	102	4.4	17	0.7	30	1.3
Mean	2,040	289	14.2	423	20.7	146	7.2	15	0.7	52	2.5
Rural area											
Less than 2,300	1,476	33	2.2	186	12.6	297	20.1	245	16.6	150	10.1
2,300–3,399	1,865	57	3.1	272	14.6	296	15.9	213	11.4	250	13.4
3,400–4,499	1,972	75	3.8	337	17.1	284	14.4	179	9.1	291	14.8
4,500–6,799	2,098	88	4.2	410	19.5	311	14.8	176	8.4	270	12.9
6,800–8,999	2,212	104	4.7	465	21.0	301	13.6	149	6.7	271	12.3
9,000–15,799	2,420	123	5.1	551	22.8	302	12.5	117	4.8	294	12.1
15,800–22,599	2,611	161	6.2	557	21.3	321	12.3	134	5.1	232	8.9
22,600–31,599	2,715	169	6.2	660	24.3	286	10.5	111	4.1	234	8.6
More than 31,599	2,784	191	6.9	663	23.8	273	9.8	98	3.5	146	5.2
Mean	2,354	122	5.2	506	21.5	300	12.7	140	5.9	256	10.9

Source: Fundação Instituto Brasileiro de Geografia e Estatística, "Special Runs of ENDEF: Consumption in Calories by Global Income Classes; Annex-A: Number of Days Researched; Annex-B: Average Number of Comensal Days," FIBGE, Rio de Janeiro (mimeographed).

[a] Wheat products include wheat bread, macaroni, and wheat flour.

Table 11—Estimated per capita distribution of yearly costs and benefits of the wheat consumption policy, metropolitan area of Belo Horizonte

Household Expenditure Group	Annual per Capita Expenditure (PCE)	Annual per Capita Subsidy (PCS)	Change in Consumer Welfare (CCW)	Percent of PCS	Social Cost	Percent of PCS	$\frac{CCW}{PCE} \cdot 100$
(1974 Cr $)		(1974 Cr $)			(1974 Cr $)		(percent)
Less than 4,500	1,604	33.8	32.8	97	1.0	3	2.04
4,500–8,999	1,749	33.7	32.0	95	1.7	5	1.83
9,000–11,299	2,549	40.1	38.0	95	2.1	5	1.49
11,300–15,799	2,692	41.2	39.1	95	2.1	5	1.45
15,800–22,599	3,793	42.6	40.7	97	1.9	3	1.07
22,600–31,599	4,453	48.2	46.6	99	1.6	1	1.05
31,600–45,199	5,919	54.1	53.7	99	0.4	1	0.91
45,200–67,799	10,869	53.3	52.8	99	0.5	1	0.49
More than 67,799	27,494	55.4	54.6	99	0.8	1	0.20

Source: Calculated by the authors based on data provided by Fundação Instituto Brasileiro de Geografia e Estatística.
Note: Wheat products include wheat bread, macaroni, and wheat flour used directly by consumers.

be less money to allocate to other products. Moreover, the medium- and low-income groups will lose more, relative to their total expenditures, than the high-income groups.

In the rural areas, both the amount consumed and the expenditures on wheat products increase as the expenditure groups ascend. However, the budget shares present a stable maximum for the middle groups (the same figure applies for more than one stratum), while declining as total expenditure increases. These data support the hypothesis that in rural areas, the consumption subsidy has benefited the higher expenditure groups in absolute terms and the medium expenditure groups in relative terms.

A comparison of energy consumption as a percentage of total kilocalories consumed per day in the metropolitan area with that in the rural areas (Table 10) shows clearly that the wheat consumption policy has discriminated against rural consumers because wheat products play a smaller part in their diets. Moreover, in both rural and urban areas, the higher the expenditure group, the higher the consumption of wheat products in absolute terms.

Taking the observations for the urban and rural areas together, one can conclude that much of the budgetary cost of the wheat consumption subsidy was captured by those who were not targeted—those in the high- and medium-expenditure groups. Thus the cost-effectiveness of this general price subsidy was probably quite low.[29]

For purposes of comparison, data on budget share and calorie consumption for rice, beans, cassava flour, and maize are also included in Tables 9 and 10. In the Belo Horizonte metropolitan area, rice had the largest budget share among the five products. This implies that a general price consumption subsidy on rice (at the same subsidy level as wheat) would do a better job of redistributing income, provided the price elasticities of demand by income groups for both products behaved similarly.

For the metropolitan area, all other products in Tables 9 and 10 are better suited to be target-oriented than wheat products (in terms of a general price subsidy to benefit low-income people). That is, both budget shares and per capita calorie consumption in general tend to decline as expenditure increases. However, the decline is less rapid for wheat products than it is for other products.

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[29] The cost incurred by the government per unit of change in nutrient consumption by the target group was high, that is, the effectiveness of the money spent in that program was low. Some figures are presented in Appendix 3.

Estimates of the price elasticities of demand for wheat products and for rice are presented in Table 12. The absolute sizes of the elasticities for bread and macaroni tend to increase as income increases and to decline at higher expenditure levels. Atypically, the price elasticity of demand for wheat flour increases continuously in absolute terms as income increases. For rice, the price elasticity declines continuously as family income increases.

Distributional Effects

The effects of the 1974/75 consumption subsidy on the distribution of expenditure of the population of the Belo Horizonte metropolitan area are quantified using the data presented in Appendix 1, Tables 26 and 27, and Table 11, and the formulas developed earlier in this chapter (equations 28-35). These calculations provide a rough idea of the distributional effects of the consumption policy when the distortion in the exchange rate is taken into account (Table 11).

The amount of subsidy per capita estimated by expenditure group increases with the increase in expenditure level because the quantity of wheat products consumed increases as income rises. Consumer welfare as a percentage of the per capita subsidy increases for all groups except the second and the eighth. This is primarily a result of the size and behavior of the different price elasticities of demand for wheat bread, macaroni, and wheat flour (Table 12). The results presented in Table 11 were obtained from the summation of these individual results.[30]

The social cost is greater for the low- and medium-expenditure consumers than for the upper expenditure groups primarily because of the size of the price elasticity of demand.

The last column of Table 11 shows the relative effects of the consumption subsidy on the consumers' real expenditures. The first four expenditure groups have a greater relative gain than the remaining groups. These results suggest that a cut in the consumption subsidy would hurt the low and medium expenditure groups relatively more than the higher ones.

In an attempt to evaluate the effects of transferring the consumption subsidy from wheat to rice, the same policy measures were estimated for rice as for wheat in Table 13, with its value of the subsidy expected to be the same. (For details on the methodology and data set used to derive the results in Table 13, see Appendix 2.) Three main advantages appear to favor a rice subsidy over wheat. First, the change in consumers' welfare is larger for the expenditure groups up to the sixth with the exception of the first (lowest) group. Second, the social costs are low due to the lower price elasticity of demand. And finally, the increase in the real expenditure power, represented by the percentage of increase in expenditure due to the subsidy, is larger for the simulated rice subsidy, which can be seen by comparing the last columns of Tables 11 and 13. All of these results are mainly due to the higher per capita consumption of rice in all expenditure groups, especially the lowest, and to the small and decreasing size of the price elasticities of demand for rice as income increases (see the last column of Table 13).

Table 14, which is derived from Tables 11 and 13, and Appendix 1, Table 28, presents the cumulative distribution of consumers' total expenditures and change in welfare for both wheat and rice. Those cumulative distributions are used for drawing the concentration curves in Figure 10.[31] With the exception of the first two expenditure strata, the distribution of the change in consumers' welfare when the consumption subsidy is on rice is slightly biased toward the two lowest expenditure groups. This is because the cumulative percentage of the change in consumers' welfare for rice is almost always greater than that for wheat, and it is also greater than the cumulative percentage of the population.

Figure 10 shows five basic curves. Curve A is the change in the consumers' welfare

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[30] The individual results are not presented but can be obtained from the authors.

[31] These curves have interpretations analogous to the Lorenz curve for income distribution.

Table 12—Estimates of direct price elasticities of demand for wheat products and rice, by income group, Juiz de Fora, Minas Gerais, 1973

Household Income Group	Demand Elasticities			
	Wheat Bread	Macaroni	Wheat Flour	Rice
(Cr $)				
Less than 4,591	−0.199	−0.119	−0.284	−0.153
4,591−7,143	−0.427	−0.144	−0.472	−0.150
7,144−10,053	−0.486	−0.127	−0.512	−0.126
10,054−13,158	−0.484	−0.107	−0.528	−0.105
13,159−18,645	−0.407	−0.082	−0.553	−0.078
18,646−32,978	−0.220	−0.058	−0.566	−0.058
32,979−44,991	0.000	−0.041	−0.559	−0.040
44,992−74,876	0.000	−0.028	−0.575	−0.026
74,877−166,835	0.000	−0.014	−0.589	−0.014

Source: João Carlos Garcia, "Avaliação dos Impactos do Aumento na Oferta de Alimentos e Renda sobre a Nutrição Humana e suas Implicações para o Estabelecimento de Prioridades de Pesquisas Agrícolas no Brasil" (Ph.D. dissertation, Universidade Federal de Viçosa, 1978).

distribution when the subsidy is on rice. Curve B is the perfect equality curve. Curve C is the same as curve A, but the subsidy is on wheat. Curve D is the expenditure distribution curve. And finally, curve E is the line of perfect inequality.

Some important deductions can be drawn from Figure 10. First, because curve A is above curve B, except for the first two expenditure groups, the distribution of benefits of a rice consumption subsidy is biased toward low-expenditure people. The reverse is true for curve C. However, since curve C is above curve D, the wheat consumption subsidy—though biased toward high-expenditure groups—has some power to redistribute expenditure and income because it increases the purchasing power.

The main problem with both the subsidies on wheat and rice is their low cost-effectiveness, as the result of a large spillover of benefits to nontargeted groups. This will be shown in Appendix 3.

A final question is, "Which consumption subsidy would be better from a nutritional standpoint?" Both wheat and rice products are rich calorie sources; therefore, the per capita daily gain in calories due to the sub-

Table 13—Estimated per capita distribution of yearly costs and benefits of the general price subsidy on rice in metropolitan area of Belo Horizonte

Household Expenditure Group	Annual per Capita Expenditure (PCE)	Annual per Capita Subsidy (PCS)	Change in Consumer Welfare (CCW)	Social Cost	Percent of PCS	$\frac{CCW}{PCE} \cdot 100$
(1974 Cr$)		(1974 Cr$)		(1974 Cr$)		(percent)
Less than 4,500	1,604	29.5	28.8	0.7	2.3	1.80
4,500−8,999	1,749	47.5	46.3	1.2	2.5	2.65
9,000−11,299	2,549	50.8	49.5	1.3	2.6	1.94
11,300−15,799	2,692	51.4	50.1	1.3	2.5	1.86
15,800−22,599	3,793	51.9	50.6	1.3	2.5	1.33
22,600−31,599	4,453	49.5	48.2	1.3	2.6	1.08
31,600−45,199	5,919	45.0	43.9	1.1	2.4	0.007
45,200−67,799	10,869	42.2	42.1	1.1	2.6	0.004
More than 67,799	27,494	35.1	34.2	0.9	2.6	0.001

Source: Calculated by the authors.

Table 14—Cumulative share of consumers' expenditure and change in consumers' welfare per expenditure group, Belo Horizonte, 1974

Household Expenditure Group	Cumulative Share of Consumer Welfare[a]	Cumulative Share of Total Expenditure[a]	Cumulative Share of CCW with Wheat Subsidy[b]	Cumulative Share of CCW with Rice Subsidy[b]
(Cr $)		(percent)		
Less than 4,500	1.2	0.3	0.9	0.8
4,500–8,999	11.3	2.9	8.3	11.0
9,000–11,299	18.4	5.6	14.4	18.6
11,300–15,799	33.6	11.6	27.9	35.1
15,800–22,599	51.3	21.5	44.3	54.6
22,600–31,599	67.8	32.4	61.8	71.9
31,600–45,199	81.0	43.9	78.0	84.6
45,200–67,799	89.5	57.6	87.0	92.2
More than 67,799	100.0	100.0	100.0	100.0

Source: Calculated by the authors.

Note: CCW is the change in consumer welfare.

[a] Obtained from Columns 3 and 4 of Appendix 1, Table 28.

[b] Obtained from cumulative multiplication of the changes in consumer welfare from Table 11 by the number of consumers in Appendix 1, Table 28.

[c] Obtained from cumulative multiplication of the changes in consumer welfare from Table 13 by the number of consumers in Appendix 1, Table 28.

sidy for each product is evaluated (Table 15). In both cases, the increase in calorie consumption was relatively small—less than 1.5 percent of per capita calorie consumption—because of the relatively low values of the price elasticities of demand for both products. In effect, the subsidies were working more as an income transfer than as an instrument to stimulate food consumption directly.

The spillover effect of these subsidies on either wheat or rice is large because the

Table 15—Estimated daily increase in energy consumption due to a general price consumption subsidy on wheat and rice, Belo Horizonte, 1974

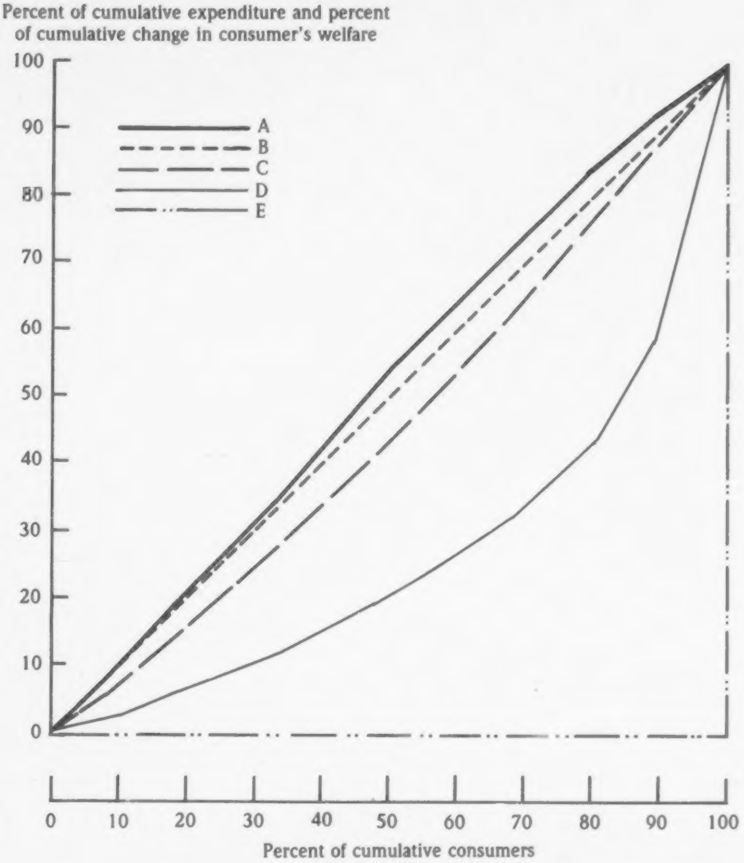
Household Expenditure Group	Calories Consumed[a]	Daily per Capita Increase in Calorie Consumption		
		Wheat Subsidy[b]	Rice Subsidy[b]	Percent of Increase from Wheat to Rice
(Cr $)				
Less than 4,500	1,447	10	16	60
4,500–8,999	1,812	12	25	108
9,000–11,299	1,832	20	27	85
11,300–15,799	1,877	26	27	4
15,800–22,599	1,909	24	27	13
22,600–31,599	2,008	19	26	37
31,600–45,199	2,132	6	23	283
45,200–67,799	2,164	6	22	267
More than 67,799	2,314	9	18	122

Sources: Calculated by the authors. Per capita calorie consumption is from Fundação Instituto Brasileiro de Geografia e Estatística, "Special Runs of ENDEF: Consumption in Calories by Global Income Classes," FIBGE, Rio de Janeiro, 1974 (mimeographed).

[a] This column is the actual per capita calorie consumption less the increase in calorie consumption due to the wheat consumption subsidy in effect in 1974.

[b] These columns were obtained from the model used in this chapter.

Figure 10—Consumers' welfare distribution



Notes: A = change in distribution of consumer welfare with rice subsidy; B = perfect equality; C = the change in distribution of consumer welfare with wheat subsidy; D = expenditure distribution; and E = inequality.

nontarget group—consumers above the third expenditure stratum—consumes a larger amount of the wheat or rice consumed. If the primary goals of subsidizing food consumption are to improve income distribution and the nutritional status of the poor, then rice is slightly better than wheat because the increase in calorie consumption for the rice subsidy is greater than that for the wheat subsidy. In the case of wheat, a general price subsidy is even more costly because the present wheat consumption policy directs the subsidy to the wheat grain that millers buy from the government. Pereira Soares reports that during the period 1967-77 millers appropriated approximately one-third of the value of the subsidy through manipulations in the production of special wheat flour and in the marketing of bran, which was not under strong government control.[32]

In the case of rice, even if there were

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[32] Pereira Soares, *Avaliação Econômica da Política Triticola.*

better distributional characteristics (see Figure 10), a general price subsidy would be difficult to administer because of a lack of organizational structure.[33] If the government's real goals are a more equitable distribution of income and improvement in the nutritional status of the poor, which kind of program should the government undertake?

Some simple estimations of the costs of alternative consumption policies are presented in Appendix 3. However, this topic deserves a more careful analysis in future research.

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[33] L. E. Carvalho, "Caráter Social de Política de Subsídio ao Trigo."

5

CONCLUSIONS

During the period 1966-82, the Brazilian government's sustained effort to achieve self-sufficiency in wheat production through a production policy that consisted of a guaranteed producer price keyed to the cost of producing wheat led to a producer price that was generally above border prices evaluated at official exchange rates and below border prices evaluated at shadow exchange rates. This policy, in terms of increased wheat production, showed positive results in 4 years and negative results in 13 others, compared with the levels of production if the free market had prevailed at the shadow exchange rate. Largely because the cruzeiro was persistently overvalued during this period, the producer subsidy in most cases only offset the tax from a distorted exchange rate.

Throughout the period, aggregate wheat consumption increased mainly as a consequence of the explicit general price subsidy, and, with the exception of seven years (1966-72), this increase was greater than the increases in wheat production when valued at the official exchange rate. As a whole, the explicit production subsidy was able to reduce net imports only during the seven years referred to above. The gains in production were small, especially after discounting for the increase in seed demand for the following year as a result of increases in area planted.

The wheat production policy for the whole period represented an estimated net subsidy of Cr$11.6 billion and an estimated net tax of Cr$15.3 billion in 1977 real cruzeiros, evaluated at official and shadow exchange rates respectively. This was due in part to the rise in the price of wheat in the world market in the mid- and late 1970s, at which time the domestic price set by the government fell short of the border price. In addition, the overvaluation of the cruzeiro represented a tax on producers.

The estimated social costs of the production policy for the whole period were Cr$2.1 billion at the official rate and Cr$2.9 billion at the shadow rate. The effects on foreign exchange induced by the production policy were estimated to be a savings of about Cr$5.0 billion at the official rate and an expenditure of Cr$16.4 billion at the shadow rate. This result was contrary to the stated objectives of the explicit production policy.

The total costs of the wheat consumption subsidies for the whole period were about Cr$84.0 billion and Cr$149.9 billion evaluated at official and shadow exchange rates respectively. Of this total, consumers captured a maximum of 86 percent. However, approximately one-third of the total subsidy was captured by the nontarget group, one-third was lost through the manipulations of the millers,[34] and social costs amounted to about 15 percent of the total cost. Thus, only about 19 percent of the total subsidy was captured by the true target group, the low-income consumers. Clearly, the wheat consumption subsidy is a poor program from the viewpoint of cost-effectiveness. This conclusion is reinforced by the results obtained through the alternative consumption policy analysis in Appendix 3, in which a general price subsidy for bread was ranked in third place and had a cost 4.5 to 7.4 times greater than that of a food stamp program.

In foreign exchange expenditure, the wheat consumption subsidy program cost Cr$29.7 billion in real 1977 cruzeiros evaluated at the official exchange rate and Cr$54.1 billion at the shadow. This level of expenditure was not in accord with the objective of achieving a saving in foreign exchange. The effects of the production and consumption policies together are the sum of individual effects of each policy.

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[34] Pereira Soares, *Avaliação Econômica da Política Tritícola.*

Based on the disaggregative analysis, one can conclude that, even though the gains in consumer welfare are slightly biased toward high-expenditure groups, the wheat consumption subsidy contributed to the income redistribution objective by distributing the benefits of the subsidy more equitably. When the subsidy costs for wheat were shifted to rice in a simulated general price subsidy, the distribution of the gains became slightly biased toward the low-expenditure groups. However, two main points should be made: first, even if a cut in the wheat consumption subsidy (or the simulated rice subsidy) harms the low- and medium-expenditure groups more, the drop in real expenditure is small (less than 2 percent). Second, the effect on nutrition was slight—less than 1.5 percent of the total per capita energy intake.

Finally, based on cases studied in the alternative consumption policy analysis (Appendix 3), one can conclude that the wheat consumption subsidy is not a good policy for redistributing income, nor is it a good instrument for dealing with malnutrition. The alternative consumption policy analysis shows that if food consumption is to be subsidized, the subsidy should be through a target-oriented program, such as food stamps.

Many of the parameters used in this analysis came from secondary sources. In some cases they were estimated for a period of time other than that of the study and under somewhat different conditions. The results could be improved with updated estimates of parameters for aggregate supply and demand, disaggregate demand by income groups, shadow prices of foreign exchange, and individual intake of wheat products by income groups.

Once estimates of the parameters of the aggregate demand and supply curves and of the disaggregated demand curves are obtained, it will be possible to develop a new set of formulas to calculate the policy measures derived in this study, thus relaxing the assumption of constant demand and supply parameters. Relaxing that assumption would bring more realism to the analysis.

The production policy analysis could also be extended to account for the net effect of all policies that affect wheat production in each year. Such an analysis could be performed by making use of the theory of effective protection.

In addition, it would be interesting to expand the analysis of the alternative consumption policies to consider the products that are the best candidates for subsidizing in each typical macroregion of Brazil, considering the tastes and preferences of the target groups. Moreover, estimates and comparisons of the administrative costs of target-oriented programs and country-wide programs would be of interest.

Finally, a plan could be developed to phase out both subsidies—production and consumption—in order to minimize the negative effects on wheat growers and low-income consumers.

APPENDIX 1:

SUPPLEMENTARY TABLES

Data Set for the Aggregative Analysis

Table 16—Current wheat prices, 1965-82

Year	Producer Price	Miller Price	Import Price (c.i.f.)
		(Cr $/metric ton)	
1965	210	157	138
1966	265	180	158
1967	317	218	197
1968	383	273	235
1969	450	311	281
1970	490	402	300
1971	547	456	385
1972	600	511	466
1973	750	573	784
1974	1,400	713	1,478
1975	1,670	734	1,380
1976	2,130	766	1,702
1977	3,170	1,202	1,574
1978	4,150	1,432	2,506
1979	5,400	1,563	4,644
1980	11,840	2,206	11,654
1981	28,500	9,918	20,550
1982	58,823	23,921	36,051

Sources: Banco do Brasil, "Trigo Nacional," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, December 1979; Banco do Brasil, "Preços de Trigo para os Produtores e Volume de Produção," Departamento de Comercialização, do Trigo Nacional, Pôrto Alegre, RS, 1984 (mimeographed); Brazil, National Supply Superintendency, Departamento do Trigo, "Evolução do Preço do Trigo em Grão para Produtores e Moinhos e Consumo Aparente de Farinha de Trigo," SUNAB, Rio de Janeiro, 1983 (mimeographed); and Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years).

Note: The c.i.f. price was obtained by dividing the total c.i.f. value of wheat grain imports by the quantity imported.

Table 17—Total production, seed consumption, consumption by millers, and imports of wheat, 1965-82

Year	Production	Seeds	Consumption	Imports
			(metric tons)	
1965	221,576	17,602	...	2,380,659
1966	298,523	29,076	2,488,062	2,394,408
1967	364,870	47,661	2,404,039	2,446,017
1968	693,598	71,911	2,884,158	2,621,013
1969	1,146,319	117,155	2,907,855	2,355,599
1970	1,734,972	166,159	3,033,611	1,969,300
1971	2,038,632	224,831	3,209,356	1,710,521
1972	693,399	152,467	3,377,669	1,796,877
1973	1,934,439	219,351	3,797,636	2,945,548
1974	2,848,040	279,257	4,116,482	2,399,175
1975	1,582,587	344,575	4,437,274	2,082,376
1976	3,037,864	328,237	5,064,250	3,425,999
1977	2,012,842	382,699	5,252,116	2,608,068
1978	2,700,707	483,403	5,656,178	4,334,432
1979	2,881,186	402,889	6,096,512	3,650,741
1980	2,702,130	315,177	6,802,036	4,755,116
1981	2,223,632	388,272	6,097,950	4,360,034
1982	1,802,337	403,365	6,101,072	4,144,000

Sources: Banco do Brasil, "Trigo Nacional," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, December 1979; Banco do Brasil, "Preços de Trigo para os Produtores e Volume de Produção," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS 1984 (mimeographed); Brazil, National Supply Superintendency, Departamento do Trigo, "Evolução do Preço do Trigo em Grão para Produtores e Moinhos e Consumo Aparente de Farinha de Trigo," SUNAB, Rio de Janeiro, 1983 (mimeographed); and Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico dc Brasil* (Rio de Janeiro: FIBGE, various years).

Table 18—Miscellaneous data for the aggregative analysis of Brazilian wheat policy, 1965-82

Year	General Price Index, Annual Average	General Price Index, November 1977	Nominal Exchange Rate	Shadow Price Exchange Rate	Port to Mill Expenses as Percent of c.i.f. Prices[a]	Farm to Mill Expenses as Percent of Farmgate Prices[b]
	(1977 = 100)		(Cr $/U.S. $)			
1965	5.8	6.4	1.90	2.70	0.15	0.09
1966	8.1	8.9	2.22	3.90	0.15	0.09
1967	10.4	11.1	2.67	4.90	0.15	0.11
1968	12.9	13.9	3.38	5.70	0.15	0.14
1969	15.5	16.8	4.08	6.50	0.15	0.16
1970	18.6	19.9	4.59	7.30	0.15	0.20
1971	22.4	23.8	5.29	7.30	0.15	0.20
1972	26.2	27.6	5.93	8.20	0.15	0.19
1973	30.2	31.8	6.13	8.30	0.15	0.16
1974	38.8	42.3	6.79	9.00	0.15	0.16
1975	49.6	54.7	8.19	10.70	0.15	0.11
1976	70.1	79.9	10.67	14.30	0.15	0.13
1977	100.0	111.0	14.14	19.00	0.18	0.19
1978	138.7	157.3	18.07	24.00	0.16	0.20
1979	213.5	263.7	26.85	33.60	0.14	0.22
1980	427.5	561.8	52.71	61.50	0.13	0.15
1981	897.3	1,118.8	93.12	120.10	0.13	0.15
1982	1,753.7	2,185.2	179.51	228.20	0.14	0.16

(continued)

Table 18—Continued

Notes and Sources: The price elasticity of demand for wheat grain for the whole period was −0.25 and that for supply was 0.75 (A. Rojko et al., *Alternative Futures for World Food in 1985,* Foreign Agricultural Economics Report No. 14 [Washington, D.C.: U.S. Department of Agriculture, 1978]). The general price index is from Fundação Getúlio Vargas, *Conjunctura Econômica,* various issues. The nominal exchange rate is from the International Monetary Fund, *International Financial Statistics* (Washington, D.C.: IMF, 1983). The shadow price of the exchange rate was calculated by the authors for each year, based on the shadow price of foreign exchange estimated by the World Bank at Cr$61.50 per U.S.$1.00 for the year 1980 (World Bank, *Brazil: Industrial Policies and Manufactured Exports* (Washington, D.C.: World Bank, 1981], Annex 2). The authors' estimate was made on the basis of the purchasing power parity method (data set and methodology are available from Geraldo Calegar upon request).

[a] Because data on port-to-mill expenses are not available for the years 1965-75, a simple average from 1976-82 is used here. Data for the latter years are found in Commission for Production Financing, "Preços e Custos Domésticos Internacionais Distorções, Um Estudos Preliminar," Au[illegible]83 (mimeographed).

[b] Farm-to-mill expenses are calculated from Banco do Brasil, "Farm [illegible] Expenses," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, 1983 (mimeograph[illegible]

Table 19—Estimated production and consumption subsidies, evaluated at official and shadow prices of foreign exchange, 1965-82

	Production Subsidy[a]		Consumption Subsidy[b]	
Year	Official Exchange Rate	Shadow Exchange Rate	Official Exchange Rate	Shadow Exchange Rate
	(percent)			
1965	55.0	−8.0	1.1	30.4
1966	45.5	−17.6	0.9	43.6
1967	45.8	−20.7	3.8	47.6
1968	49.7	−11.1	−1.0	40.1
1969	49.4	−6.5	3.8	39.6
1970	59.3	0.2	−16.5	26.7
1971	40.0	1.1	−3.0	25.4
1972	26.4	−8.5	4.6	31.1
1973	−8.2	−32.3	36.4	53.1
1974	−12.4	−33.9	58.0	68.4
1975	5.8	−18.9	53.8	64.6
1976	8.2	−19.5	60.9	70.8
1977	83.5	36.2	35.3	51.8
1978	51.1	15.8	50.8	63.2
1979	0.5	−19.5	70.5	76.4
1980	−21.7	−32.6	83.2	85.6
1981	13.6	−12.3	57.3	66.9
1982	32.7	4.8	41.8	54.2

Source: Calculated by the authors.

[a] Nominal rate of protection for producers.

[b] Nominal rate of protection for consumers.

Table 20—Estimated effects of wheat production and consumption policies on quantities produced, consumed, and imported, based on the official exchange rate, 1966-82

Year	Change in Production in Year t−1[a]	Percent[b]	Partial Change in Imports in Year t[c]	Percent[b]	Consumption in Year t	Percent[b]	Total Change in Imports in Year t[d]	Percent[b]
	(1,000 metric tons)		(1,000 metric tons)		(1,000 metric tons)		(1,000 metric tons)	
1966	40.3	15.5	−33.3	−1.4	5.9	0.2	−27.4	−1.1
1967	72.3	22.9	−60.6	−2.4	23.1	1.0	−37.6	−1.5
1968	89.5	15.1	−70.6	−2.6	−7.2	−0.3	−77.8	−2.9
1969	181.7	18.4	−151.4	−6.1	27.9	1.0	−123.5	−5.0
1970	296.4	20.4	−247.5	−10.6	−118.1	−3.8	−365.6	−15.7
1971	511.5	28.5	−461.8	−21.0	−23.9	−0.7	−485.7	−22.1
1972	450.7	71.1	−426.1	−19.5	40.1	1.2	−386.0	−17.7
1973	112.0	5.6	−126.8	−4.8	407.0	12.0	280.2	10.5
1974	−130.8	−4.4	101.7	6.8	803.4	24.3	905.1	60.6
1975	−296.4	−19.1	310.9	31.3	777.9	21.3	1,088.8	109.6
1976	66.8	2.3	−48.7	−2.0	1,058.7	26.4	1,009.8	41.8
1977	167.9	10.5	−28.4	−1.4	541.4	11.5	513.0	24.5
1978	733.3	31.2	−617.8	−15.3	918.1	19.4	300.3	7.4
1979	757.6	26.4	−755.5	−27.0	1,602.8	35.7	847.3	30.2
1980	15.8	0.1	−77.9	−3.3	2,450.5	56.3	2,372.6	99.6
1981	−532.1	−25.0	566.5	21.6	1,168.6	23.7	1,735.2	66.1
1982	197.2	12.2	−119.1	−3.4	772.1	14.5	653.0	18.7

Source: Calculated by the authors.

[a] The production of year t − 1 is consumed in year t.

[b] The percentages represent the degree of difference in production, consumption, and imports that would have been observed if world prices had prevailed.

[c] The partial change in imports in year t is the result of the production subsidy in year t − 1 alone. It is given by $\{-CQP_{t-1} - [QP_{t-1} - (SP_t - SW_t)]\}$, where CQP is the change in quantity produced, QP is the quantity produced at the subsidized price, SP is the quantity of seeds used at the subsidized producer price, and SW is the quantity of seeds used if the world price had prevailed.

[d] The total change in imports includes the effects of both producer and consumer subsidies.

Table 21—Estimated effects of wheat production and consumption policies on quantities produced, consumed, and imported based on the shadow exchange rate, 1966-82

Year	Change in Production in Year t−1[a]	Percent[b]	Partial Change in Imports in Year t[c]	Percent[b]	Consumption in Year t	Percent[b]	Total Change in Imports in Year t[d]	Percent[b]
	(1,000 metric tons)		(1,000 metric tons)		(1,000 metric tons)		(1,000 metric tons)	
1966	−14.3	−4.1	9.8	0.5	332.0	15.4	341.8	16.7
1967	−46.7	−10.8	37.7	1.8	358.4	17.5	396.1	19.3
1968	−69.3	−9.1	62.7	2.8	346.9	13.7	409.6	18.5
1969	−63.9	−5.3	57.9	3.0	344.4	13.4	402.3	20.6
1970	−58.8	−3.4	59.0	3.5	227.1	8.1	286.1	17.0
1971	2.2	0.1	−0.4	−0.03	226.3	7.6	225.9	15.2
1972	16.9	2.3	−27.4	−1.8	299.9	9.7	272.5	17.9
1973	−48.0	−1.9	−26.6	−1.2	654.4	20.8	627.8	27.1
1974	−657.9	−16.9	556.3	68.3	1,028.8	33.3	1,585.1	194.7
1975	−1,036.3	−55.9	977.6	1,082.6	1,014.5	29.6	1,992.1	2,206.1
1976	−269.7	−7.5	211.7	11.3	1,431.3	36.0	1,552.0	82.8
1977	−537.0	−33.6	616.1	55.6	876.8	20.0	1,492.9	133.9
1978	415.9	16.3	−365.5	10.6	1,251.8	28.4	886.3	25.7
1979	281.7	8.3	−352.9	−16.4	1,847.8	43.5	1,494.9	69.3
1980	−509.0	−14.0	400.7	23.0	2,615.1	62.5	3,015.8	173.4
1981	−928.7	−37.9	888.7	44.5	1,472.4	31.8	2,361.1	118.1
1982	−228.9	−13.2	242.9	8.6	1,082.4	21.6	1,325.3	47.0

Source: Calculated by the authors.

[a] The production of year t − 1 is consumed in year t.

[b] The percentages represent the degree of difference in production, consumption, and imports that would have been observed if world prices had prevailed.

[c] The partial change in imports in year t is the result of the production subsidy in year t − 1 alone. It is given by $\{-CQP_{t-1} - [QP_{t-1} - (SP_t - SW_t)]\}$, where CQP is the change in quantity produced, QP is the quantity produced at the subsidized price, SP is the quantity of seeds used at the subsidized producer price, and SW is the quantity of seeds used if the world price had prevailed.

[d] The total change in imports includes the effects of both producer and consumer subsidies.

Table 22—Estimated effects of the production policy, based on the official exchange rate, 1966-82

	Total Subsidy (Tax) Cost (TC)		Change in Producers' Welfare		Social Cost (SC)		Effect on Foreign Exchange (EF)		
Year	Cr$ Million	Percent	Cr$ Million	Percent of TC	Cr$ Million	Percent of TC	Cr$ Million	Percent[a]	Ratio of SC to EF
1966	299.4	100	263.7	88.1	35.7	11.9	162.1	2.9	0.22
1967	362.0	100	318.2	87.9	43.8	12.1	195.0	3.5	0.22
1968	725.5	100	632.1	87.1	93.4	12.9	380.6	6.5	0.25
1969	1,171.5	100	1,022.6	87.3	148.9	12.7	618.0	11.2	0.24
1970	1,908.5	100	1,632.6	85.5	275.9	14.5	948.6	20.6	0.29
1971	1,592.2	100	1,418.7	89.1	173.5	10.9	890.6	20.8	0.19
1972	375.8	100	345.7	92.0	30.1	8.0	229.2	5.9	0.13
1973	−481.7	100	−498.0	103.4	16.3	3.4	−389.8	−4.8	0.04
1974	−1,546.5	100	−1,627.6	105.2	81.1	5.2	−1,301.8	−14.1	0.06
1975	299.1	100	292.8	97.9	6.3	2.1	213.3	3.1	0.03
1976	668.3	100	649.9	97.2	18.4	2.8	469.0	4.7	0.04
1977	3,101.8	100	2,550.8	82.2	551.0	17.8	1,362.0	21.9	0.40
1978	2,679.1	100	2,363.9	88.2	315.2	11.8	1,457.7	13.0	0.22
1979	51.9	100	51.7	99.6	0.2	0.4	38.7	0.4	0.01
1980	−1,772.6	100	−1,948.7	109.9	176.1	9.9	−1,637.7	−12.6	0.11
1981	758.3	100	724.8	95.6	33.5	4.4	510.2	4.3	0.07
1982	1,404.0	100	1,269.7	90.4	134.3	9.6	818.0	7.8	0.16
Total	11,596.6	100	9,462.9	81.6	2,133.7	18.4	4,963.7	3.7	0.43

Source: Calculated by the authors.
Note: Cr$ million are in real 1977 cruzeiros.
[a] Percent = EF · 100/(total cost of wheat imports + EF).

Table 23—Estimated effects of the production policy, based on the shadow exchange rate, 1966-82

	Total Subsidy (Tax) Cost (TC)		Change in Producers' Welfare		Social Cost (SC)		Effect on Foreign Exchange (EF)		
Year	Cr$ Million	Percent	Cr$ Million	Percent of TC	Cr$ Million	Percent of TC	Cr$ Million	Percent[a]	Ratio of SC to EF
1966	−207.5	100	−223.9	−107.9	16.4	7.9	−184.3	−2.0	0.09
1967	−302.1	100	−331.1	−109.6	29.0	9.6	−277.3	−2.9	0.10
1968	−271.9	100	−284.5	−104.6	12.6	4.6	−226.0	−2.5	0.06
1969	−245.3	100	−251.6	102.6	6.3	2.6	−195.0	−2.6	0.03
1970	8.7	100	8.7	100.0	0.0	0.0	6.5	0.1	0.00
1971	61.2	100	60.9	99.5	0.3	0.5	45.4	1.0	0.00
1972	−167.1	100	−172.9	103.5	5.8	3.5	−135.5	−2.7	0.04
1973	−2,526.4	100	−2,962.8	117.3	436.4	17.3	−2,658.6	−28.8	0.16
1974	−5,604.9	100	−6,642.7	118.5	1,037.8	13.5	−6,019.8	−76.1	0.17
1975	−1,251.8	100	−1,359.4	108.6	107.6	8.6	−1,127.1	−14.9	0.10
1976	−2,217.6	100	−2,415.4	108.9	197.8	8.9	−2,009.3	−18.6	0.10
1977	1,815.6	100	1,630.5	89.8	185.1	10.2	1,037.8	13.8	0.18
1978	1,199.1	100	1,137.0	94.8	62.1	5.2	790.6	6.1	0.08
1979	−1,743.1	100	−1,898.5	108.9	155.4	8.9	−1,579.2	−16.2	0.10
1980	−3,161.5	100	−3,713.6	117.5	552.1	17.5	−3,337.3	−24.3	0.17
1981	−909.5	100	−956.6	105.2	47.1	5.2	−764.5	−5.5	0.06
1982	259.5	100	255.0	98.3	4.5	1.7	186.8	1.5	0.02
Total	−15,264.6	100	−18,120.9	118.7	2,856.3	18.7	−16,446.8	−10.5	0.17

Source: Calculated by the authors.
Note: Cr$ million are in real 1977 cruzeiros.
[a] Percent = EF · 100/(total cost of wheat imports + EF).

Table 24—Estimated effects of the consumption policy, based on the official exchange rate, 1966-82

Year	Total Subsidy (Tax) Cost (TC)		Change in Consumers' Welfare		Social Cost (SC)		Effect on Foreign Exchange (EF)		Ratio of SC to EF
	Cr$ Million	Percent	Cr$ Million	Percent of TC	Cr$ Million	Percent of TC	Cr$ Million	Percent[a]	
1966	52.2	100	52.1	99.8	0.1	0.2	−13.1	0.24	0.01
1967	197.1	100	196.2	99.5	0.9	0.5	−50.0	0.95	0.02
1968	−60.6	100	−60.7	100.2	0.1	0.2	15.1	0.27	0.01
1969	229.7	100	228.6	99.5	1.1	0.5	−58.3	1.20	0.02
1970	−928.3	100	−945.8	101.9	17.5	1.9	219.0	5.66	0.08
1971	−189.4	100	−190.0	100.3	0.6	0.3	46.8	1.37	0.01
1972	[illegible]	100	319.0	99.4	1.9	0.6	−81.7	2.27	0.02
1973	[illegible]	100	3,889.6	94.1	242.2	5.9	−1,214.6	16.03	0.20
1974	10,468.2	100	9,264.1	88.5	1,204.1	11.5	−3,520.1	50.35	0.34
1975	7,632.1	100	6,856.7	89.8	775.4	10.2	−2,489.6	59.65	0.31
1976	8,604.2	100	7,532.0	87.5	1,072.2	12.5	−2,955.1	44.70	0.36
1977	3,440.1	100	3,246.9	94.4	193.2	5.6	−1,005.0	26.18	0.19
1978	6,940.1	100	6,223.3	89.7	716.8	10.3	−2,272.7	30.23	0.32
1979	10,656.7	100	8,908.7	83.4	1,748.0	16.6	−3,975.2	78.27	0.44
1980	17,440.4	100	13,191.4	75.6	4,249.0	24.4	−7,546.9	106.31	0.56
1981	9,043.4	100	8,025.0	88.7	1,018.4	11.3	−3,024.5	36.62	0.34
1982	5,979.1	100	5,558.1	93.0	420.0	7.0	−1,810.5	22.91	0.23
Total	83,957.7	100	72,295.2	86.1	11,661.5	13.9	−29,736.4	30.68	0.39

Source: Calculated by the authors.
Note: Cr$ million are in real 1977 cruzeiros.
[a] Percent = EF · 100/(total cost of wheat imports + EF).

Table 25—Estimated effects of the consumption policy, based on the shadow exchange rate, 1966-82

Year	Total Subsidy (Tax) Cost (TC)		Change in Consumers' Welfare		Social Cost (SC)		Effect on Foreign Exchange (EF)		Ratio of SC to EF
	Cr$ Million	Percent	Cr$ Million	Percent of TC	Cr$ Million	Percent of TC	Cr$ Million	Percent[a] of TC	
1966	4,277.0	100	3,957.7	92.5	319.3	7.5	−1,308.7	16.1	0.24
1967	4,572.5	100	4,186.1	91.6	386.4	8.4	−1,432.9	17.2	0.27
1968	4,086.9	100	3,814.9	93.3	272.0	6.7	−1,225.7	15.3	0.22
1969	3,823.8	100	3,573.8	93.5	250.0	6.5	−1,143.5	17.1	0.22
1970	2,393.5	100	2,298.1	96.0	95.4	4.0	−669.9	13.0	0.14
1971	2,220.9	100	2,137.8	96.3	83.1	3.7	−617.5	15.3	0.13
1972	2,965.6	100	2,823.8	95.2	141.8	4.8	−847.7	20.0	0.17
1973	8,145.9	100	7,334.6	90.0	811.3	10.0	−2,645.0	28.6	0.31
1974	16,334.2	100	13,815.2	84.6	2,519.0	5.4	−5,972.8	75.1	0.42
1975	11,980.6	100	10,320.5	86.1	1,660.1	13.9	−4,240.3	95.0	0.39
1976	13,415.2	100	11,195.0	83.5	2,220.2	16.5	−5,018.9	64.3	0.44
1977	6,796.7	100	6,143.3	90.4	653.4	9.6	−2,188.7	50.6	0.30
1978	10,039.7	100	8,701.1	86.7	1,338.6	13.3	−3,513.9	40.6	0.38
1979	14,454.8	100	11,628.4	80.5	2,826.4	19.5	−5,733.5	102.5	0.49
1980	20,963.7	100	15,384.5	73.5	5,552.2	26.5	−9,398.3	122.2	0.59
1981	13,616.7	100	11,602.0	85.2	2,014.7	14.8	−4,915.2	51.0	0.41
1982	9,853.2	100	8,838.5	89.7	1,014.7	10.3	−3,224.4	35.4	0.31
Total	149,913.9	100	127,755.3	85.2	22,158.6	14.8	−54,096.9	45.4	0.41

Source: Calculated by the authors.
Note: Cr$ million are in real 1977 cruzeiros.
[a] Percent = EF · 100/(total cost of wheat imports + EF).

Data Set for the Disaggregative Analysis

Table 26—Annual per capita expenditures on wheat products and rice, by expenditure group, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75

Expenditure Group	Wheat Bread and Crackers	Macaroni	Wheat Flour	Rice
		(Cr$)		
Metropolitan area				
Less than 4,500	30	25	2	70
4,500–8,999	37	20	1	105
9,000–11,299	57	28	2	154
11,300–15,799	62	23	2	144
15,800–22,599	82	27	2	164
22,600–31,599	137	33	5	143
31,600–45,199	170	30	5	132
45,200–67,799	150	28	5	154
More than 67,799	189	30	10	131
Rural areas				
Less than 2,300	2	6	0	39
2,300–3,399	6	12	1	77
3,400–4,499	6	11	2	93
4,500–6,799	9	16	2	112
6,800–8,999	15	20	3	159
9,000–15,799	18	18	7	163
15,800–22,599	25	25	10	190
22,600–31,599	35	22	12	221
More than 31,599	61	29	14	265

Source: Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional da Despesa Familiar: Despesas das Famílias, Dados Preliminares*, 6 vols. (Rio de Janeiro: FIBGE, 1978 and 1979).

Note: Wheat products include bread and crackers, macaroni, and wheat flour.

Table 27—Energy consumption from wheat products and rice per consumer per day, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75

Expenditure Group	Wheat Bread and Crackers	Macaroni	Wheat Flour	Rice
		(kilocalories/consumer/day)		
Metropolitan area				
Less than 4,500	73	109	7	274
4,500–8,999	107	83	6	435
9,000–11,299	132	94	10	465
11,300–15,799	152	84	11	470
15,800–22,599	166	79	12	475
22,600–31,599	199	79	19	453
31,600–45,199	252	69	18	412
45,200–67,799	265	53	20	386
More than 67,799	274	48	34	321
Rural areas				
Less than 2,300	4	28	1	186
2,300–3,399	13	42	2	272
3,400–4,499	13	52	10	337
4,500–6,799	17	60	14	410
6,800–8,999	25	65	14	465
9,000–15,799	32	61	30	551
15,800–22,599	37	79	45	557
22,600–31,599	58	69	42	660
More than 31,599	71	70	50	663

Source: Fundação Instituto Brasileiro de Geografia e Estatística, "Special Runs of ENDEF: Consumption in Calories by Global Income Classes," FIBGE, Rio de Janeiro, n.d. (mimeographed).

Note: Wheat products include bread and crackers, macaroni, and wheat flour.

Table 28—Data for derivation of expenditures and changes in consumer welfare curves, Belo Horizonte, 1974/75

Household Expenditure Group	Per Capita Expenditure	Number of Consumers	Total Expenditure
(Cr$)	(Cr$)	(1,000)	(Cr$1,000)
Less than 4,500	1,604	22	37,102
4,500–8,999	1,749	184	321,816
9,000–11,299	2,549	128	326,272
11,300–15,999	2,692	275	740,300
16,000–22,599	3,793	320	1,213,760
22,600–31,599	4,453	300	1,335,900
31,600–45,199	5,919	240	1,420,560
45,200–67,799	10,869	155	1,684,695
More than 67,799	27,494	190	5,223,860
Total	. . .	1,814	12,304,265

Source: Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional da Despesa Familiar: Despesas das Famílias, Dados Preliminares,* 6 vols. (Rio de Janeiro: FIBGE, 1978).

Note: Total expenditure is the per capita expenditure times the number of consumers.

APPENDIX 2:
A SIMPLE MODEL FOR ANALYZING THE EFFECTS OF SHIFTING THE SUBSIDY FROM WHEAT TO RICE

When the market for rice in Belo Horizonte is viewed as an undistorted market (that is, without government intervention), it can be depicted in equilibrium at price P_o and quantity Q_o, according to Figure 11. DD is the demand for rice and SS is the supply of rice. It is assumed that SS is infinitely elastic because the Belo Horizonte market is a relatively small fraction of the Brazilian market. To determine the effect on the price of rice of transferring the consumption subsidy from wheat to rice, in order to use the methodology in Chapter 4 to evaluate the distributional effects of that transfer, the following equations related to Figure 11 must be solved:

$$(P_o - P_1)Q_1 = TCS, \qquad (36)$$

$$Q_o = aP_o^{-\eta}, \text{ and} \qquad (37)$$

$$Q_1 = aP_1^{-\eta}, \qquad (38)$$

where

P_o and Q_o = the equilibrium free market price and quantity;

P_1 and Q_1 = the postsubsidy equilibrium price and quantity;

TCS = the total cost of the subsidy of wheat transferred to rice, that is, area P_o ABP P_1 in Figure 11;

a = the demand shifter; and

η = the price elasticity of demand for rice in Belo Horizonte.

As can be seen, the demand function is assumed to be of constant elasticity.

In the system above, the values for P_o, Q_o, and TCS have been estimated from secondary sources, as shown in the table below.

	Estimate
P_o	Cr$3.25/kg
Q_o	377 kg/year
η	−0.13
TCS	Cr$402.00/year
P_1	Cr$2.23/kg

Here P_0 is an average price per kilogram paid by consumers in the metropolitan area of Belo Horizonte in August 1974, calculated by dividing the annual per capita expenditures on rice[35] by the annual per capita consumption of rice,[36] after converting to kilograms, considering that 1 kilogram = 3,570 calories.[37]

Q_o is the average quantity used (41.9 kilograms per year) multiplied by nine, which is an average of the nine expenditure strata. η is an average from estimates made by Paniago and Mandell for Brazil.[38] TCS, the total cost of the subsidy, is obtained from Table 12. It is a summation of all nine figures of the third column. Finally, P_1 is obtained from the solution of equation (39) below.

After substituting the known variables above into the system defined earlier and solving for P_1, the following equation is obtained:

$$377 \cdot (3.25)^{1.13} \cdot (P_1)^{-0.13} - 377 \cdot (3.25)^{0.13} \cdot (P_1)^{0.87} - 402 = 0. \qquad (39)$$

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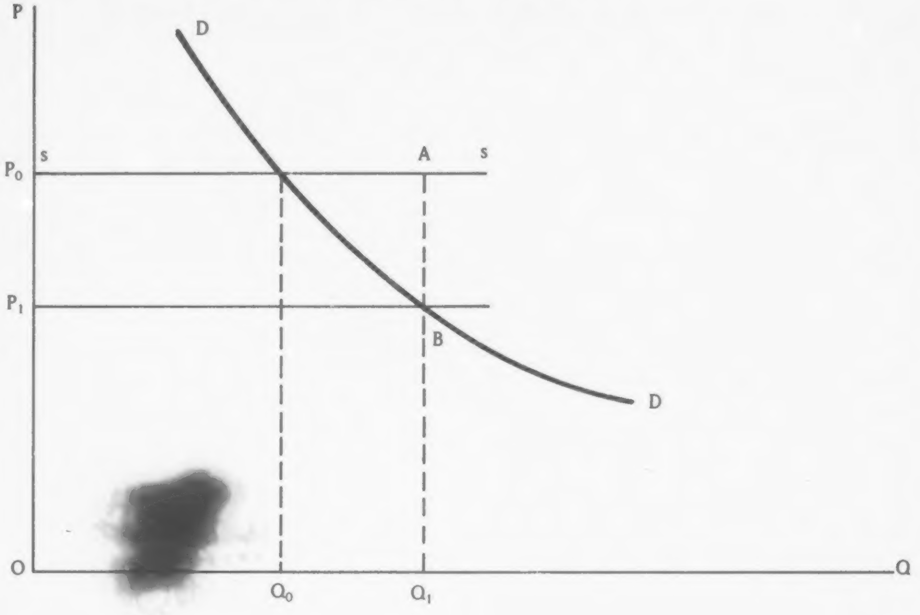
[35] Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional da Despesa Familiar: Despesas das Famílias, Dados Praliminares,* 6 vols. (Rio de Janeiro: FIBGE, 1978) Region 4, p. 65, first column.

[36] Fundação Instituto Brasileiro de Geografia e Estatística, "Special Runs of ENDEF: Consumption in Calories by Global Income Classes," Rio de Janeiro, n.d., Region 4, p. 29 (mimeographed).

[37] Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional de Despesa Familiar: Tabelas de Composição de Alimentos,* 2nd edition (Rio de Janeiro: FIBGE, 1981), p. 22.

[38] Euler Paniago, "An Evaluation of Agricultural Price Policies for Selected Food Products: Brazil," (Ph.D. dissertation, Purdue University, 1969); and P. I. Mandell, "A Expansão da Moderna Rizicultura: Crescimento de Oferta numo Economía Dinâmica," *Revista Brasileira de Economía* 26 (July/September 1972): 169-236.

Figure 11—Retail market for rice in Belo Horizonte



APPENDIX 3:
ALTERNATIVE CONSUMPTION POLICIES: A MODEL AND SOME RESULTS

Among the many questions to be answered before any policy option is chosen, questions of fiscal cost and cost-effectiveness are perhaps the most important if one considers that public resources are scarce and therefore must be allocated as efficiently as possible. In this appendix, a simple model suggested by Reutlinger and Selowsky is presented to estimate the fiscal cost and cost-effectiveness of three basic policy options for improving the nutritional status of target groups in any society.[39]

Two large typologies of policies are identified for study: country-wide and target-group-oriented programs. In the first case, all segments of society benefit in the process of benefiting the target or deficient group; in the second case, only the target group receives the benefits. In other words, there is no spillover effect. The country-wide policy to be considered is a general price subsidy, whereas the target-oriented programs include a food stamp program and a price subsidy.

The Model

Under the assumption that the policy objective is to increase the consumption of a specific food in the target group by a fraction λ of the initial consumption of that food item by the target group, let α represent the share of consumption of that food by the target group (in the present case a low-income group).

If there are only two consumer groups, the target or low-income group (p), and the remaining, or richer group (r), with respective price elasticities of demand for the food item, η_p and η_r, one can define η_t as

$$\eta_p + (1 - \alpha)\eta_r,$$

where η_t is the total demand price elasticity for the commodity, expressed as the weighted average of the demand elasticities of both groups in absolute values.

First, an expression is derived to compute the fiscal cost (FC) of a general price subsidy, taking into account the policy objective defined above and the parameters of supply and demand for the target group or the whole population whenever necessary. Departing from the definitions of supply and demand elasticities and considering the market equilibrium after the general price subsidy has been instituted, two equations are obtained of the form:

$$\eta_p = (dq/dp^d)(P_o/q_o)$$

$$+ dp^d = \lambda/\eta_p, \text{ and} \qquad (40)$$

$$\eta_t dp^d = \varepsilon_t dp^s + dp^s = (\eta_t/\varepsilon_t)\, dp^d, \qquad (41)$$

where

q_o = the quantity of the commodity consumed by the target group, or αQ_o, where Q_o is the total consumption of the aggregated consumers;

dp^d, dp^s = percent of changes in the demand and supply prices, respectively;

ε_t = elasticity of total supply for the commodity; and

λ = dq/qo.

Substituting equation (40) into equation (41) gives

$$dp^s = (\eta_t/\eta_p)(\lambda/\varepsilon_t)\, P_o. \qquad (42)$$

With FC as the fiscal cost of the general price subsidy under consideration, the equation can be written:

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[39] Shlomo Reutlinger and Marcelo Selowski, *Malnutrition and Poverty: Magnitude and Policy Options* (Baltimore: Johns Hopkins University Press for the World Bank, 1976).

$$FC_G = (dp^d + dp^s)$$
$$[Q_o + \eta_t dp^d(Q_o/P_o)], \qquad (43)$$

which, after substituting equations (41) and (42) into (43), becomes

$$FC_G = P_oQ_o(\lambda/\eta_p)[1 + (\eta_t/\varepsilon_t)]$$
$$[1 + \lambda(\eta_t/\eta_p)]. \qquad (44)$$

If $\varepsilon_t \rightarrow \infty$, the product could have an infinitely elastic supply curve (which could be the case if it is an imported product for which the country is a small buyer in the world market), then equation (44) becomes

$$FC_G = P_oQ_o(\lambda/\eta_p)[1 + \lambda(\eta_t/\varepsilon_p)]. \qquad (45)$$

In order to obtain the unitary cost of the general price consumption subsidy, UC_G (the cost incurred by the government for each additional unit of the consumption good by the target group), it is only necessary to divide equations (44) and (45) by dq (the total increase in consumption of the good by the target group with respect to the initial consumption level of the target group) as follows:

$$UC_G = (FC_G/\lambda\alpha Q_o). \qquad (46)$$

In order to derive expressions for the fiscal cost and the unitary cost of target-oriented programs using the same set of parameters as above, one must depart from Figure 12. Figure 12 represents the market for a food product that is relevant for the low-income target group, where D_p represents the demand by the group as a function of initial income Y, and S_p represents the excess supply faced by the target group. Therefore, $S_p = S_t - D_r$, where S_t and D_r are the total supply and demand of the non-target (upper-income) group.

Initial consumption and price are q_o and P_o, respectively.

The objective of the policy as set forth earlier is to induce an increase in consumption of the food product by the target group by $\lambda = \Delta q/q_o$. First, some basic expressions are derived that will be used later in computing the fiscal and unitary costs of the alternative policy options for the target group.

The increase in price needed to induce an increment in supply equal to Δq is equal to Δ_1. Denoting ε_p as the elasticity of supply faced by the target group, the following expression may be defined:

$$\varepsilon_p = [(\Delta_q/q_o)/(\Delta_1/P_o)]$$
$$+ (\Delta_1/P_o) = (\lambda/\varepsilon_p). \qquad (47)$$

If the decline in price required to induce the target group to increase consumption by λ is equal to Δ_2, then the following expression may be defined (in absolute value):

$$\eta_p = [(\Delta_q/q_o)/(\Delta_1/P_o)]$$
$$+ (\Delta_2/P_o) = (\lambda/\eta_p). \qquad (48)$$

Now the respective formulas for calculating the fiscal cost and unitary costs of a price subsidy and a food stamp program are derived.

First, if the possibility of subsidizing just the consumption of the target group is considered, then the fiscal cost of that subsidy will be

$$FC_s = (q_o + \Delta_q)(\Delta_1 + \Delta_2). \qquad (49)$$

Substituting from equations (47) and (48) and recalling that $q_o = \alpha Q_o$ and $q = \lambda\alpha Q_o$, one obtains:

$$FC_s = P_oQ_o\alpha\lambda(1 + \lambda)(1/\varepsilon_p + 1/\eta_p), \qquad (50)$$

and if $\varepsilon_p \rightarrow \infty$, then

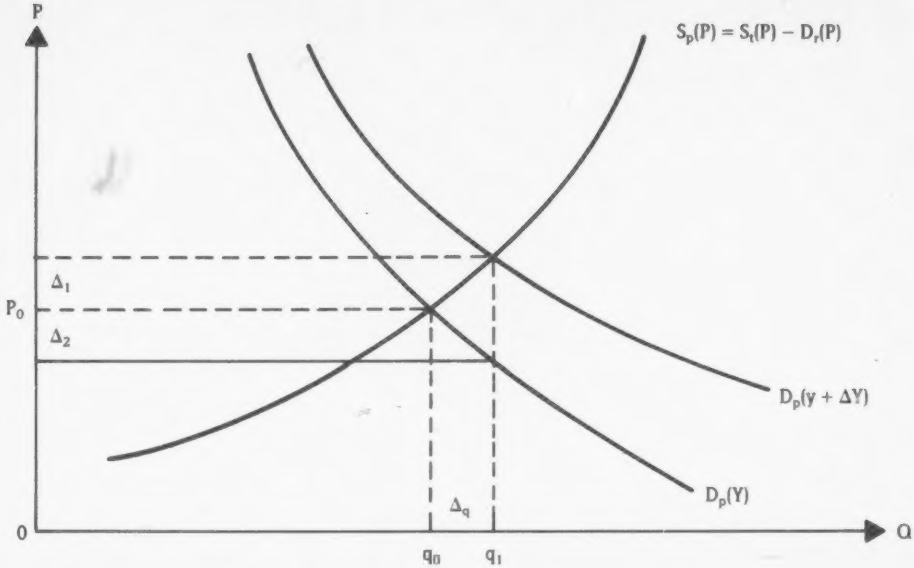
$$FC_s = P_oQ_o(\alpha\lambda/\eta_p)(1 + \lambda), \qquad (51)$$

and the unitary cost UC_s will be

$$UC_s = FC_s/\alpha\lambda Q_o. \qquad (52)$$

Next, the cost of a food stamp program is considered. The question now is, "What is the value of the income transfer or the fiscal cost FC_{FS} required to induce an increase in physical consumption of a specific product i by the target gorup in Δ_q?" Note that the value of the transfer must be able

Figure 12—Hypothetical market for a relevant product for a target group



to finance the increment Δ_q—valued at the new supply price of the product—as well as to finance the increased cost of the old consumption q_o. The transfer or fiscal cost of the program becomes

$$FC_{FS} = \Delta_1(q_o + \Delta_q) + P_o\Delta_q, \text{ and}$$

$$FC_{FS} = P_oQ_o\alpha\lambda\{[(1 + \lambda)/\varepsilon_p] + 1\}. \qquad (53)$$

If $\varepsilon_p \to \infty$, then

$$FC_{FS} = P_oQ_o\alpha\lambda. \qquad (54)$$

The unitary cost of the additional consumption due to the program is given by

$$UC_{FS} = FC_{FS}/\alpha\lambda Q_o. \qquad (55)$$

Cost-Effectiveness of Alternative Policies

Once the disaggregative model has been applied to a comparison of the relative costs of a food stamp and a price subsidy program for a target group with a general price subsidy for food in Brazil as a whole, the cost-effectiveness of these programs can be considered. Although a search of the literature did not yield an ideal set of parameters for estimating the cost-effectiveness of the programs, those parameters that were available were used with the sensitivity analysis shown in Table 29 in order to account for possible variations. The programs, ranked in order of cost-effectiveness, were food stamp program, target-oriented price subsidy, and general price subsidy.

The difference between the cost-effectiveness of the target-oriented price subsidy and the food stamp program, for the alternative values of ε and η_p, ranged from 11 percent ($\varepsilon = 0.14$ and $\eta_p = 1.0$) to 62 percent ($\varepsilon = 0.14$ and $\eta_p = 0.7$). This means that the target-oriented price subsidy is less cost-effective than the food stamp program, but the difference was not large in comparison with the ineffectiveness of the general price subsidy (last line of Table 29). To make one dollar of food available for the target group, the cost ranged from 5.62 percent ($\varepsilon = 0.8$ and $\eta_p = 1.0$) to 27.16 percent ($\varepsilon = 0.14$ and $\eta_p = 0.7$). This means that the differences in cost-effectiveness be-

Table 29—Cost-effectiveness of target-group-oriented programs and a general food price subsidy program with different demand and supply elasticities, as a ratio of the price per unit, 1984

Program	Formula	Wheat Bread[a]		Rice[a]		Edible Beans[a]	
		−1.0	−0.7	−1.0	−0.7	−1.0	−0.7
Target group							
Food stamp	$1 + [(1 + \lambda)/\varepsilon_p]$	1.25	1.25	1.56	1.56	1.80	1.80
Price subsidy	$(1 + \lambda)(1/\varepsilon_p + 1/\eta_p)$	1.45	1.96	1.76	2.27	2.00	2.91
General							
Price subsidy	$1/\alpha\eta_p(1 + \eta_t/\varepsilon)(1 + \lambda\eta_t/\eta_p)$	5.62	9.30	9.54	16.73	15.02	27.16

Source: Calculated by the authors.

Notes: The value of ε was obtained according to the method described in A. C. Pastore, "A Oferta de Produtos Agrícolas no Brasil," *Estudos Econômicos* 7 (No. 1, 1975): 29-64. The values of $\lambda = 0.20$, $\alpha = 0.30$, and $\eta_r = 0.2$ were assumed by the authors. In order to get η_t and η_p, the following formulas were used: $\eta_t = \eta_p + (1-\lambda)\,\eta_r$ and $\varepsilon_p = \varepsilon/\lambda + (1-\alpha) \cdot \eta_r/\alpha$.

[a] For wheat bread, the value of $\varepsilon = 0.8$ ($\varepsilon_p = 4.8$); for rice, it is $\varepsilon = 0.27$ ($\varepsilon_p = 2.15$); and for edible beans, it is $\varepsilon = 0.14$ ($\varepsilon_p = 1.50$), and for each product respectively $\eta_p = -1.0$ and -0.7.

tween the general price subsidy and the food stamp program ranged from 3.5 to 14 times.

This is a significant difference. If it were possible to shift from the present general price subsidy for wheat in Brazil to a food stamp program, it would certainly lead to a large gain in cost-effectiveness. With the same amount of financial resources, the per capita benefits for the target group (here assumed to be $\alpha = 30$ percent of the population) would be considerably larger. A shift from the general price subsidy for wheat to a food stamp program would strongly contribute to reducing the budget deficit without lowering the nutritional status of low-income people.

It is clear that this simple exercise should be improved, and more sophisticated methodologies should be used, taking into account not only the direct but also the cross-effects, to evaluate more carefully the real and monetary effects of different programs to improve the nutritional status of the low-income population in Brazil.

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RESEARCH REPORT

67

NATURE AND IMPACT OF THE GREEN REVOLUTION IN BANGLADESH

Mahabub Hossain

July 1988

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NATURE AND IMPACT OF THE GREEN REVOLUTION IN BANGLADESH

Mahabub Hossain

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FOREWORD

The International Food Policy Research Institute has always emphasized the role of modern technology in increasing the food supply of low-income countries. The growth in productivity that results from technology diffusion generates linkage effects that can lead to all-around economic development. IFPRI is profoundly concerned about the policies needed to encourage and increase the effectiveness of technology adoption and to maximize agricultural growth linkage effects in achieving major social objectives such as alleviation of poverty. It is clear that for poor, land-scarce countries like Bangladesh, food supplies necessary to meet even minimum expected growth rates of population and per capita income during the next few decades cannot be realized without development of higher-yielding cereal varieties and their accelerated spread to farmers' fields. Failure to increase food supplies at a matching rate will increase food prices and accentuate poverty, since the poor spend a large proportion of their income on food.

This report by Mahabub Hossain, a staff member of the Bangladesh Institute of Development Studies (BIDS), Dhaka, is an outcome of IFPRI's continuing research efforts on the above issue. The report assesses the pace of diffusion of the seed-fertilizer-water technology in Bangladesh and the impact of this technology on the growth of production. It examines input use, productivity, and profitability of modern varieties of rice compared with traditional varieties. It evaluates the impact of technological progress on income distribution and alleviation of poverty by looking at the pattern of technology adoption among different groups of farmers and at the generation of employment for the landless in agriculture and in rural nonfarm activities through linkage effects of agricultural growth. The report concludes that in Bangladesh the new technology has opened up great opportunities to increase food production and farm income and that it has a fairly neutral income-distribution effect. The incidence of poverty is found to be substantially lower in technologically developed villages than in underdeveloped ones.

A major finding of this study is that the poor gain from the new technology through the operation of the labor market. As agricultural incomes and labor productivity increase, farm households substitute leisure for labor and supply less labor in the market. This redistributes agricultural employment from higher- to lower-income groups. Such redistribution, together with an increase in the demand for labor owing to the higher labor intensity of the modern rice varieties, puts an upward pressure on the wage rate and increases wage earnings from the same amount of labor. Some income adjustments may also take place between technologically developed and underdeveloped villages through operation of rural-rural migration of agricultural workers.

This study is one of a series of collaborative research efforts between IFPRI and BIDS since 1981. The fieldwork was carried out by BIDS in connection with a joint IFPRI/BIDS evaluation of the food-for-work program in Bangladesh, the final report of which was submitted in 1985. IFPRI is pleased to have provided support to the author in Washington, D.C., for analyzing the data and writing the present report. The study was partially funded by the Ford Foundation office in Dhaka, Bangladesh. IFPRI is grateful to the foundation for its encouragement and support of this work.

John W. Mellor

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1

SUMMARY

A major constraint to increasing food production in Bangladesh is the limited supply of land. There is little scope for expanding cultivable land beyond the 22 million acres from which the country now feeds more than 100 million people. The cultivated land area has remained unchanged since independence in 1971, although the population has increased by about 50 percent since then. The growth of cereal production since the early 1970s has barely managed to keep food imports at 10 percent of domestic demand despite a respectable progress in the diffusion of new agricultural technology, modern seed varieties of rice and wheat, and chemical fertilizers.

Technological progress is the key to maintaining the national food-population balance—and the scope for further diffusion of the new technology is vast. Only about a third of the rice and wheat area has been covered with modern-variety seeds, and the consumption of chemical fertilizers has reached 18 nutrient kilograms per acre. But because of the results of early studies on the "green revolution" in India, there is widespread apprehension in Bangladesh that diffusion of the new technology may contribute to worsening income inequality and deepening absolute poverty.

There have been few systematic and representative studies on Bangladesh that examined the effects of technological change at the farm and economy levels. In 1979-82 a survey was made of 2,400 sample farms in 117 villages throughout the country; a second large survey of 16 villages was completed in 1981-82. This study analyzes these two sets of survey data to assess the effects of modern rice technology on productivity and equity.

The yield of paddy is estimated at 1.34 metric tons per acre for modern varieties, compared with 0.65 ton for local varieties, and the estimated profit is Tk 2,300 and Tk 1,050, respectively. In Bangladesh, where land is so scarce and the size of landholdings so small, high profit per acre is important, but cost per ton of output is a more conclusive measure of profitability. The cost per ton of paddy output was Tk 3,700 for local varieties and Tk 3,000 for the new varieties, clearly demonstrating that the value of increased output exceeded the increased costs of growing the modern varieties. At 1984/85 prices the net return to family labor was Tk 87 per day for modern varieties and Tk 75 for local varieties, compared with the agricultural wage rate of Tk 24 per day.

Small farmers and tenants adopted the new technology as readily as did medium and large ones. Farmers operating less than 2.5 acres of land allocated 52 percent of their rice land to modern varieties, compared with 45 percent for those with 2.5-5.0 acres and 42 percent for those with 5.0 acres of land or more. The yield per acre was also higher on smaller farms. But profits and family income were lower on smaller farms because they paid about 25 percent higher water charges and about 10 percent higher wage rates than the large farms. The profits were substantially less on rented land, since the tenant has to pay 50 percent of the gross produce as rent and bear all costs of inputs. But the profits per acre on tenant farms were higher for the modern varieties than for local varieties. Diffusion of the new technology thus increases income for all groups of farmers, but also increases the inequality in the distribution of agricultural income among farm households.

To get an overall indication of the effect of new technology on income distribution, the survey villages were divided into two equal groups according to the degree to which the new technology was used. In the technologically developed villages, 54 percent of the land was irrigated and farmers allocated 61 percent to modern rice varieties, compared with 8 and 5 percent, respectively, for the underdeveloped villages. The difference in fertilizer use was eight times between the two groups of villages. In the developed villages, total household income was 29 percent higher and per capita income 22 percent higher than in the underdeveloped villages. However, the comparative patterns of income distribution for all rural households (including the landless) show a neutral effect for the new technology. The Gini concentration ratio of household income was the same (0.39) in the two groups of villages, but the concentration ratio measured along the per capita income scale was slightly higher in the developed villages (0.36) than in the underdeveloped ones (0.34). The comparison of income for the two groups of villages in the per capita income scale shows that the relative position of the bottom 40 percent of the households remained unchanged, while the top 20 percent gained relatively at the expense of the middle 40 percent. The proportion of population living below the poverty line was 32 percent in the developed villages and 47 percent in the underdeveloped villages.

The positive effect of the new technology on alleviation of poverty resulted from substantial increases in the income of the functionally landless households (which have less than 0.5 acre of land and are the bottom one-third of households in the landholding scale) through higher employment and wages. The annual income for this group of households was about Tk 14,300 in the developed villages compared with Tk 9,700 in the underdeveloped villages—the difference in income for the landless between the two groups of villages was almost equal to that for the large landowners (with 5.0 acres of land or more). The farmers used 45 percent additional labor in growing modern varieties. Irrigation, by increasing cropping by about one-third, also increased the demand for labor. But as income increases, higher-income households substitute leisure for labor and supply less labor in the market. The increased labor demand is met by more employment for the functionally landless in developed villages and for lower-income households in underdeveloped villages. Total employment was 4 percent higher in the developed villages; for the functionally landless group it was 26 percent higher. The new technology also puts a significant upward pressure on the wage rate, which is another factor behind increases in the income of the poor. The wage rate for agricultural labor was about 25 percent higher in the developed villages than in the underdeveloped ones.

The growth of income from the new technology expands the market for nonfarm goods and services. In the underdeveloped villages, households spent about 60 percent of the marginal budget on the output of the crop and forestry sectors, which are land-based; in the developed villages, the share was 47 percent. The marginal budget share of rural services, which are mostly labor-based, and in which the poor are more involved, was about 18 percent in developed villages and 7.5 percent in underdeveloped villages. The expenditure pattern thus appears to be another mechanism through which some benefits of the new technology trickle down to lower-income groups.

The increased income, however, does not promote capital accumulation in agriculture or in nonfarm activities. The rate of directly productive investment is estimated at 7.3 percent of total expenditure in the developed villages, compared with 11.7 percent in the underdeveloped villages. The high-income group spends proportionately more for improvement of housing and for transfers, such as purchases of land. Households in developed villages acquired about 32 percent of the land through the market, compared with 25 percent for underdeveloped villages. The impact of the new technology on the land market may cause further concentration of landholding and greater inequality in the distribution of agricultural income.

Thus there is a case for siphoning off from the upper income groups some of the surplus accumulated through technological diffusion. This may be achieved through higher agricultural taxation and the cost recovery of public investment in agriculture. It may be advisable to withdraw subsidies on sales of irrigation equipment to individuals, since such sales mostly benefit the large and medium landowners. A reallocation of public investment from major irrigation projects to small-scale projects with pumps and tubewells—to the extent it is technically feasible—may also save resources, because the cost recovery from large-scale projects has proved to be extremely difficult. The government will need additional resources from domestic sources for irrigation investment and for strengthening agricultural research, extension, and credit institutions to promote further diffusion of the new technology. The present low levels of cereal prices in international markets and political pressures from cereal-surplus developed countries suggest that it may be increasingly difficult for the government to mobilize foreign aid for this purpose.

2

INTRODUCTION

There are few countries in the Third World where technological progress is of higher importance in maintaining the food-population balance than in Bangladesh. The country now supports a population of more than 100 million people with a density of 700 per square kilometer. The growth rate of population, which has started declining only recently, is still about 2.3 percent a year. Since per capita income is extremely low, nearly two-thirds of the income is spent on food. The income elasticity of demand for food (mostly rice) is variously estimated at 0.53-0.73.[1] Thus, if the country is to maintain a modest per capita income growth of about 2 percent a year, which has been the case since it gained independence from Pakistan in 1971, food production has to grow at over 3.4 percent a year to avoid a further increase in cereal imports, which are currently about 10 percent of domestic demand.

But agriculture does not have the resources to meet that challenge. Practically all cultivable land is in use, and the pressure of increasing population reduced the average size of a farm holding from 3.53 acres in 1960 to 2.25 acres in 1983/84.[2] The increase in intensity of land use through raising additional crops during a year (cropping intensity), which was the major source of growth of crop production until the late 1960s, has slowed down considerably in recent years. Nearly 85 percent of the cropped land is devoted to production of cereals, indicating that there is little scope for diversion of land from nonfood to food crops. Since Bangladesh was densely populated decades earlier (200 persons per square kilometer in 1901), the possibility of increasing production through additional use of labor in individual crop varieties may also have been exhausted long ago.

Thus, rapid technological progress is the key to maintaining the food-population balance in the country. This was recognized by the government in the early 1960s. At that time farmers rarely used modern agricultural inputs such as chemical fertilizers and irrigation. Fertilizer application was limited to tea gardens and government experimental farms, and irrigation was practiced on about 7 percent of the land, using labor-intensive indigenous methods. The major constraints to application of modern agricultural inputs were the flooding of land during the rainy season and the lack of irrigation facilities during the dry season. Recognizing that farmers would not come forward to make indivisible investments in modern irrigation equipment because of the small farm size and the scattered and fragmented nature of holdings, the government set up the Bangladesh Water Development Board (BWDB), with responsibility for developing the water resources of the country through multipurpose flood control, drainage, and irrigation projects. At the same time, the Bangladesh Agricultural Development Corporation (BADC) was established to procure modern irrigation equipment, chemical fertilizers, and improved seeds and distribute them among farmers at highly subsidized prices.

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[1] For various estimates of the income and expenditure elasticity of the demand for food for Bangladesh, see Wahiduddin Mahmud, "Foodgrain Demand Elasticities of Rural Households in Bangladesh: An Analysis of Pooled Cross-Section Data," *The Bangladesh Development Studies* 7 (No. 1, 1979): 59-70; Bangladesh, Bureau of Statistics, *Report of the Bangladesh Household Expenditure Survey, 1981-82* (Dhaka: Ministry of Planning, 1986), pp. 34-39; and Raisuddin Ahmed, *Agricultural Price Policies under Complex Socioeconomic and Natural Constraints*, Research Report 27 (Washington, D.C.: International Food Policy Research Institute, 1981), pp. 52-56.

[2] Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84*, vol. 1 (Dhaka: Ministry of Planning, 1986), pp.32-33.

Thanks to the efforts of these institutions, Bangladesh has experienced some progress in the use of modern agricultural inputs over the last 25 years. The modern varieties (MVs) of rice seeds developed in international research stations were made available to farmers for dry season (boro) crops in 1968 and wet season (aman) crops in 1970, but their diffusion really picked up after the mid-1970s. By 1984/85 the area irrigated by modern methods had increased to about one-fifth of cultivated land. Irrigation, along with flood control and improved drainage, facilitated the spread of modern-input-responsive MVs, which now cover about one-fourth of cropped land and one-third of sown area under cereal crops. The expansion of irrigation and the shift of cropped land from traditional varieties to MVs have been the major factors behind the rapid growth in fertilizer consumption, which rose from insignificance in the early 1960s to about 18 kilograms of nutrients per acre of cropped land in 1984/85 despite the gradual withdrawal of a subsidy on this input since the mid-1970s.[3] The above figures also indicate that the potential for further increase in production through diffusion of modern technology is still vast. It largely depends on the capacity of the government to accelerate investment in irrigation, flood control, and drainage, which determines the expansion of the other two elements of modern technology—MV seeds and chemical fertilizers.

In Bangladesh, however, modern technology is widely believed to be contributing to worsening income inequality and deepening absolute poverty.[4] This view is prevalent among development thinkers and practitioners in the country as well as within the donor community that finances most of the investment in water resource development. The growth in crop production in the postindependence period has been faster than it was during the previous two decades (1950-71),[5] but studies based on household expenditure surveys show that absolute poverty afflicts two-thirds to four-fifths of the rural population and that it worsened alarmingly during the 1970s.[6] Other indirect evidences of the deteriorating economic condition of the rural poor in the 1970s are downward trends in the real wages of agricultural laborers and in the intake of energy and protein. The results of the national nutrition surveys show that the per capita daily energy intake declined by about 9 percent between 1962-64 and 1975/76, and another 7 percent by 1981/82.[7]

In view of the above observations, concerns are expressed about the role of modern technology in improving the condition of the poor. The hypothesis is that the effect of production growth from application of modern technology is felt much more on the increase in land and labor productivity, which is appropriated mainly by the higher-income groups, than on the generation of new employment or on the increase in wage rate from which the poor may gain. This impression is obtained from early studies on the "green revolution" in India. These studies argued that, although the new agricultural technology is scale neutral, small farmers cannot participate in its diffusion as much as large ones because the new crop varieties require a large amount of investment in purchased inputs that the poor cannot afford, and small farmers have little access to financial institutions from which working capital can be borrowed on reasonable terms. Also, by making agricultural enterprises more profitable for larger farmers, the new technology forces tenants off the land as tenancy evictions follow, and the new inflated surplus of the rich is used to buy out the marginal and small landholders, forcing them into landlessness. The net result, it is argued, is a rapid increase in the inequality of income and asset distribution and a worsening of rural poverty.[8]

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[3] For details of developments in the field of fertilizer consumption, see Bruce Stone, ed., *Fertilizer Pricing Policy in Bangladesh* (Washington, D.C.: International Food Policy Research Institute/Bangladesh Institute of Development Studies, 1987).

[4] See, for example, Mosharraf Hossain, A. Rashid, and Selim Jahan, *Rural Poverty in Bangladesh: A Report to the Like-minded Group* (Dhaka: Dhaka University Press, 1986); Willem van Schendel, *Peasant Mobility: The Odds of Peasant Life in Bangladesh* (Assen, the Netherlands: Van Gorcum, 1981).

[5] Mahabub Hossain, "Agricultural Development in Bangladesh: A Historical Perspective," *The Bangladesh Development Studies* 12 (December 1984): 29-57.

[6] Azizur R. Khan, "Poverty and Inequality in Rural Bangladesh," in *Poverty and Landlessness in Rural Asia,* ed. Keith Griffin and Azizur R. Khan (Geneva: International Labour Organisation, 1977); Quazi K. Ahmad and Mahabub Hossain, "An Evaluation of Selected Policies and Programs for Alleviation of Rural Poverty in Bangladesh," in *Strategies for Alleviating Poverty in Rural Asia,* ed. Rizwanul Islam (Bangkok: International Labour Organisation, Asian Employment Programme, 1985), pp. 67-98.

[7] Nazmul Hasan and Kamaluddin Ahmad, "Studies on Food and Nutrient Intake by Rural Population of Bangladesh," *Ecology of Food and Nutrition* 15 (No. 12, 1984): 143-158.

A contrasting view, which has only recently been appreciated, is that the new technology may benefit the poor in the long run by (1) reducing the cost of production and thereby lowering the prices of food, and (2) generating more employment in nonfarm sectors by keeping real wages low and stimulating demand for nonfarm goods and services.[9] Since most of the income of the poor originates from labor, and their marginal propensity to consume food is very high, these indirect effects of technological progress are considered highly favorable. According to this view, if poverty increases it is because of technological progress too late and slow for its favorable effects to outweigh the unfavorable effects of high population growth,[10] and delays in adopting new technology will result in even more accentuation of poverty.

The above hypotheses regarding the nature and impact of the new agricultural technology have not yet been rigorously tested for Bangladesh. A large number of village studies have been undertaken to look into the effects of farm size and tenancy on productivity, and these studies provide information on adoption of MVs and use of fertilizer for different groups of farms.[11] But the studies are not based on a rigorous and systematic treatment of sufficiently large and disaggregated data, so the results are speculative and conjectural in nature and do not show any consistent pattern. The few rigorous attempts that have been made are based on data collected from one or two villages during the early 1970s when the technology had not progressed very far. The effect of the technology on employment and its indirect effects on nonfarm activity and on income distribution among rural households are also poorly documented. An in-depth investigation into the characteristics of the new technology and its effects on productivity and income distribution is overdue. This is the objective of this study.

Two large household surveys conducted in recent years provide disaggregated information that forms the basis of this study. The first of these was conducted by the

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[8] For a detailed articulation of this view, see Keith Griffin, *The Political Economy of Agrarian Change: An Essay on the Green Revolution* (Cambridge: Harvard University Press, 1974); and Andrew Pears, *Seeds of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution* (Oxford: Clarendon Press, 1980). For a detailed empirical study reporting the early results of the new agricultural technology in India, see B. H. Farmer, ed., *Green Revolution? Technology and Change in Rice-Growing Areas of Tamil Nadu and Sri Lanka* (London: Macmillan, 1977).

[9] For this view, see John W. Mellor, "Determinants of Rural Poverty: The Dynamics of Production, Technology, and Price," in *Agricultural Change and Rural Poverty,* ed. John W. Mellor and Gunvant M. Desai (Baltimore and London: Johns Hopkins University Press, 1985, pp. 21-40); and John W. Mellor, "Food Price Policy and Income Distribution in Low-Income Countries," *Economic Development and Cultural Change* 27 (October 1978): 1-26.

[10] This is supported by M. L. Dantwala, "Technology, Growth, and Equity in Agriculture," in Mellor and Desai, *Agricultural Change and Rural Poverty,* pp. 110-123.

[11] A survey of the results of these studies can be obtained from Robert W. Herdt and L. Garcia, "Adoption of Modern Rice Technology: The Impact of Size and Tenure in Bangladesh," International Rice Research Institute, Manila, 1982 (mimeographed).

International Fertilizer Development Center (IFDC) in collaboration with the Bangladesh Agricultural Research Council to study the distributional consequences of fertilizer use. This is the most comprehensive farm survey conducted so far in the country. The survey work started with the 1979 aman season crops and continued for 10 consecutive seasons up to the 1982 aman season crops. A multistage, random sampling method was used in the survey, which ultimately covered 2,400 sample farms and about 10,000 sample plots in 117 villages from 20 upazilas scattered throughout 16 of the 21 Bangladesh (old) districts. Detailed input-output data were collected at the plot level for all crops, disaggregated by the type of technology used. The unpublished plot- or farm-level data were not available, but detailed disaggregated information was presented at the crop and technology levels in the published reports of the survey,[12] which has been used here for analyzing the nature of modern varieties of rice vis-à-vis traditional ones.

The second survey was conducted by the International Food Policy Research Institute in collaboration with the Bangladesh Institute of Development Studies to evaluate the development effects of the infrastructure created under the food-for-work program in the country.[13] The survey was conducted in 16 selected villages scattered through the four administrative divisions of the country and represents the principal ecological zones. A census of all households in the selected villages was carried out to serve as the sample frame for the study. The households were classified into eight groups based on the size of the landholding (four groups) and the occupation of the head of household (agriculture or nonagriculture). A proportionate random sample was then drawn from each stratum so as to have 40 households in each village. The total sample size thus consists of 640 households and about 5,200 plots operated by them. A few sample households could not be included in the analysis because of missing observations and doubtful information. The author was involved in the design and implementation of the survey.

The fieldwork was conducted from September 1981 to January 1983, administering five sets of structural questionnaires to collect information on the pattern of land use at the plot level in calendar year 1981, costs and returns for various crops grown at the farm level during 1982, and employment, income, investment, and consumption at the household level for 1982. The disaggregated household and plot data have been analyzed here to investigate the effects of the modern technology on productivity, employment, and income.

The villages studied represent a wide range of development of modern rice technology (see Table 1). In five villages, less than 5 percent of the cropped area was covered by modern varieties of rice, while in four others more than 70 percent of the area was covered by MVs. The variation is mainly the result of access to irrigation facilities, which have been developed primarily by the government during the last two decades and mostly through foreign assistance. Such facilities were almost nonexistent in four of the villages, two of them located in the coastal district of Khulna, where salinity of the water makes irrigation development difficult. In three other districts, some of the area was irrigated by indigenous methods (swing baskets and wooden lifters called *dhones*). At the other end, there were irrigation facilities for more than 50 percent of the cultivated land in five villages, three of them located in Comilla, where irrigation

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[12] International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* and *1981/82* (Muscle Shoals, Ala.: IFDC, 1982, 1984).

[13] Bangladesh Institute of Development Studies/International Food Policy Research Institute, *Development Impact of the Food-for-Work Program in Bangladesh,* a report submitted to the World Food Programme (Washington, D.C.: International Food Policy Research Institute, 1985).

Table 1—Basic characteristics of villages under study, 1982

Village	District	Average Size of Land-holding	Average Household Size	Share of Land Irrigated	Share of Cropped Land Under Modern Varieties of Rice	Fertilizer Consumption per Acre of Cropped Land[a]	Share of Crop Area Under Tenancy
		(acres)	(persons)	(percent)	(percent)	(kilograms)	(percent)
Developed area		2.26	6.52	53.8	61.4	82.2	16.0
Chasapara	Comilla	2.14	6.80	86.9	99.5	126.4	16.4
Illashpur	Comilla	1.67	6.78	56.3	73.2	133.6	21.1
Khunta	Comilla	1.80	6.23	83.3	83.2	130.4	15.8
Harishpur	Jessore	3.72	6.88	52.9	81.0	94.3	27.1
Rawtora	Pabna	0.98	6.89	58.0	46.9	65.1	2.5
Rajarampur	Dhaka	2.61	5.40	32.9	33.9	22.2	17.1
Charkhamar	Dhaka	2.50	6.40	42.4	25.7	30.3	4.7
Bandabeel	Kushtia	2.65	6.79	36.3	24.7	32.4	13.5
Underdeveloped area		2.26	6.35	8.0	5.2	10.8	15.9
Govindapur	Dhaka	2.36	5.43	20.4	13.8	14.1	7.8
Sayedpur	Dhaka	2.03	6.30	8.8	3.2	6.9	12.9
Patgari	Pabna	1.77	6.68	12.6	10.4	13.1	5.0
Roakuli	Kushtia	3.41	6.63	3.8	4.0	18.1	3.6
Gobrapara	Jessore	3.62	7.53	3.9	0.0	7.9	19.5
Khejurdanga	Khulna	1.61	5.62	13.8	17.2	30.1	14.8
Birhat	Khulna	1.84	6.25	0.0	0.0	1.0	36.2
Taliamara	Khulna	1.45	5.05	0.0	0.0	1.3	45.7

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] The figures for fertilizer are in weights of materials (urea, phosphate, and potash), not in nutrients, which are difficult to measure accurately in the absence of information on the use of these different types of fertilizer. An approximate nutrient content may be obtained by multiplying the figures by 0.46.

facilities were developed early (in the 1960s) by the Comilla cooperative movement. The consumption of chemical fertilizer ranges from almost insignificant in the villages in Khulna to about 130 kilograms per cropped acre in the villages in Comilla and is highly related to the proportion of area under MVs.

One method used in this paper to assess the impact of technology is to compare mean values of the variables in the technologically developed and underdeveloped villages. Since only about one-fifth of the area in Bangladesh had irrigation facilities at the time of the survey, a 20 percent irrigated area was used as the cutoff figure for classifying the villages into two groups. This also divides the sample into two equal size groups, with eight villages and 317 households in each group. In the developed villages more than 60 percent of the cropped land was sown with MVs of rice, compared with only 5 percent in the underdeveloped villages. The developed villages used 82 kilograms of fertilizer per acre of cropped land compared with 11 kilograms for the underdeveloped ones (Table 1).

The pattern of land distribution for the sample households is shown in Table 2. About 30 percent of the households own up to 0.5 acre, which is considered in Bangladesh as functionally landless. This category is estimated by the recent agricultural census of Bangladesh (1983-84) at 46 percent.[14] At the other end, about 10 percent of the households own 5.0 acres or more; these are large farmers by the Bangladesh standard. Their proportion for the country as a whole is estimated at 8.5 percent. The

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[14] Bangladesh, *Census of Agriculture and Livestock*, p. 81.

Table 2—Distribution pattern of landownership in sample, 1982

Landownership Group	Number of Samples	Share of Households	Share of Land Owned	Share of Population	Average Amount of Land Owned
(acres)		(percent)	(percent)	(percent)	(acres)
Developed area	317	100.0	100.0	100.0	2.26
Less than 0.5	97	30.6	2.0	25.6	0.17
0.5–2.5	103	32.5	16.6	29.6	1.16
2.5–5.0	80	25.2	36.1	28.6	3.24
5.0–7.5	20	6.3	16.7	8.2	5.90
7.5 or more	17	5.4	28.6	8.0	12.07
Underdeveloped area	317	100.0	100.0	100.0	2.26
Less than 0.5	94	29.7	2.0	23.1	0.15
0.5–2.5	111	35.0	17.4	33.8	1.13
2.5–5.0	81	25.6	38.1	29.1	3.37
5.0–7.5	17	5.4	14.8	6.6	6.24
7.5 or more	14	4.4	27.7	7.4	14.17
Total sample	634	100.0	100.0	100.0	2.26
Less than 0.5	191	30.1	2.0	24.4	0.15
0.5–2.5	214	33.8	17.0	31.7	1.14
2.5–5.0	161	25.4	37.1	28.8	3.31
5.0–7.5	37	5.8	15.7	7.4	6.10
7.5 or more	31	4.9	28.1	7.8	13.02

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.
Note: Parts may not add to totals because of rounding.

average size of landownership for the sample is 2.26 acres, compared with 2.0 acres for Bangladesh. Thus the degree of landlessness is lower and the amount of land owned is higher for the sample than for Bangladesh. The pattern of land distribution is, however, very similar in the technologically developed and underdeveloped villages. The two groups have the same average size of landownership and the same proportion of landless households. The proportion of large farmers and their share of total land is, however, slightly higher in the developed villages. The proportion of area cultivated by tenants varies widely across villages, but the averages for the two groups of villages are similar (Table 1).

As a background to the detailed microlevel analysis that follows, Chapter 3 gives an overview of the technological progress in Bangladesh and its impact on agricultural growth and on trends in relative prices, using national data for 1950-85. The characteristics of modern varieties of rice vis-à-vis traditional ones, in terms of the use of various inputs and the implications for cost of production and profits, are described in Chapter 4, using detailed input-output information provided by the IFDC survey. The impact of technology on the productivity of land and labor and on the efficiency of resource use is analyzed in Chapter 5 through estimation of production functions and profit functions. Chapter 6 is a study of the effect of farm size and tenure on adoption of the new technology in order to assess the consequences of technological progress on the distribution of income among various groups of farmers.

To complete the assessment of equity implications of the technological diffusion, the employment effects are traced in Chapter 7 by an analysis of the supply of and demand for labor for different groups of households in the technologically developed and underdeveloped villages. Estimates of labor supply functions with disaggregated household information and of the effect of technological change on the agricultural wage rate are also given in this chapter. The issue of the indirect effects of the new technology on generation of employment and income for the poor through expansion of the market for nonfarm goods and services is taken up in Chapter 8, and the investment behavior of different landholding groups and the effects of growth of income on the land market are analyzed. The effects of technology on the level and distribution of income and on alleviation of rural poverty are summarized in Chapter 9. Finally, the implications of the major findings of the study for policies to promote rural development are discussed in Chapter 10.

3

TECHNOLOGICAL PROGRESS AND GROWTH OF CROP PRODUCTION—A MACRO PICTURE

Resource Base and the Need for Technological Progress

Continuous high growth of population has made Bangladesh an extremely land-scarce country, and land can no longer be counted as an important source of growth of agricultural production. The total area of the country is 35 million acres, of which about 60 percent is cultivated and most of the remainder is under forests, rivers, and homesteads (see Table 3). There has been little increase in cultivated land since the early 1950s (see Figure 1), and by the end of the 1960s, a type of equilibrium had been reached in the land use pattern that has since changed very little. During 1980-85, the wasteland that could be reclaimed for cultivation was only 1.9 percent of total land.

The effective supply of land could, however, be raised by growing additional crops on the same land during the year. This is indeed one of the means by which production has been increased from this limited resource base. In the early 1950s, only one-fourth of the total land was cropped more than once during the year. The intensity of cropping increased very rapidly in the 1960s—from about 130 percent in 1960/61 to 148 percent by 1969/70. The cropping intensity continued to increase after independence in 1971, but the rate of increase has slowed down (Figure 1 and Table 4). Further increase would depend on expansion of irrigation facilities, which allow the growing of additional crops on seasonally fallow land during the dry winter season (boro).

The majority of the people continue to depend on land for their livelihood because of limited expansion of nonagricultural sectors. Such expansion is inhibited partly by the small size of internal markets for nonagricultural goods and services and is perpetuated by low levels of income. The value added that is generated by manufacturing

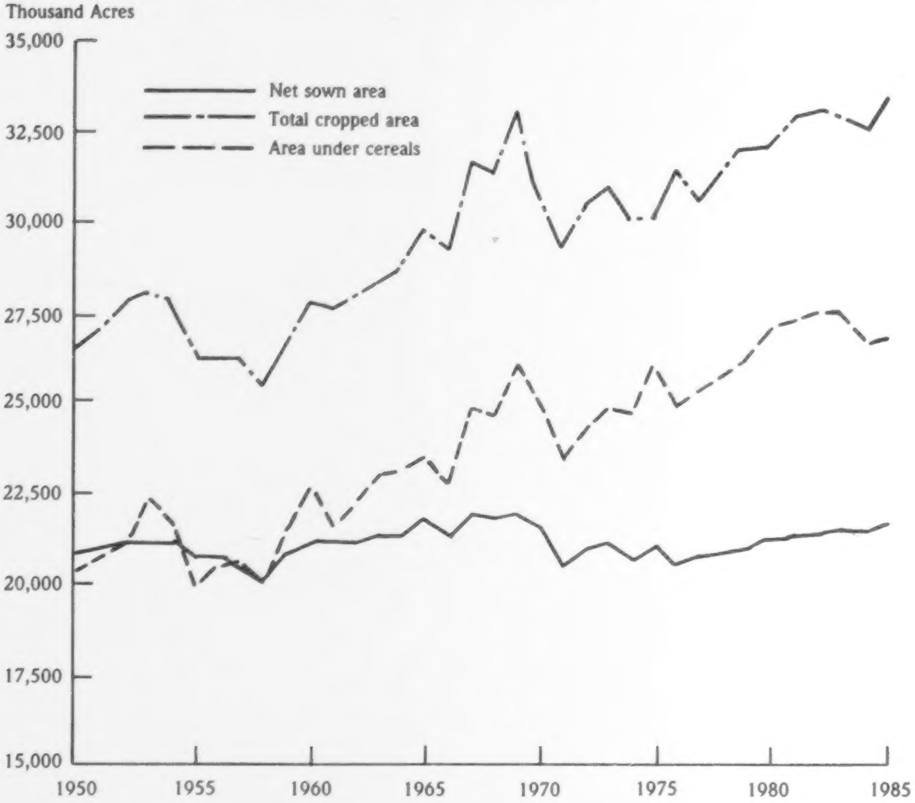
Table 3—Changes in pattern of land use, 1950-85

Land Use	1950-53 Area	1950-53 Share of Total	1967-70 Area	1967-70 Share of Total	1980-85 Area	1980-85 Share of Total
	(million acres)	(percent)	(million acres)	(percent)	(million acres)	(percent)
Cultivated land	20.7	58.7	21.7	61.5	21.3	60.0
Current fallow	1.6	4.4	0.8	2.1	1.3	3.6
Cultivable waste	2.1	5.8	0.9	2.5	0.7	1.9
Forest	5.5	15.7	5.5	15.7	5.3	15.0
Not available for cultivation (rivers, canals, homesteads, etc.)	5.4	15.3	6.4	18.2	6.9	19.2
Total land	35.3	100.0	35.3	100.0	35.4	100.0

Sources: Based on data from Pakistan, Central Statistical Office, *25 Years of Pakistan in Statistics* (Karachi: Government Press, 1972); and Bangladesh, Bureau of Statistics, *Statistical Pocket Book of Bangladesh, 1986* (Dhaka: Ministry of Planning, 1987).

Note: Parts may not add to totals because of rounding.

Figure 1—Trends in cultivated area and cropped area, 1950-85



is only about 10 percent of the gross domestic product, and the share of construction, trade, and transport services is another 20 percent. The 1983/84 labor force survey has recorded that only 8 percent of the civilian labor force is employed in manufacturing, 17 percent in construction, trade, and transport services, and 12 percent in other services.[15] Agriculture still provides employment to about 60 percent of the labor force.

Owing to the population pressure and lack of nonagricultural employment, the land is cultivated in very small holdings. Also, holdings are fragmented into many scattered plots because of Islamic laws of property inheritance. The 1977 agricultural census found that two-fifths of the farms had more than 10 fragments.[16] The small farm, defined as under 2.5 acres, is the dominant production unit. With traditional technology, such a farm is incapable of producing a subsistence income, so most small farmers also work as agricultural wage laborers and engage in various nonfarm activities during

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[15] Bangladesh, Bureau of Statistics, *Final Report: Labour Force Survey, 1983-84* (Dhaka: Ministry of Planning, 1986).

[16] Bangladesh, Bureau of Statistics, *Report on the Agricultural Census of Bangladesh, 1977* (Dhaka: Ministry of Planning, 1981).

Table 4—Changes in intensity of land use, 1950-85

Intensity of Use	1950-53 Area	1950-53 Share of Total Cultivated Land	1967-70 Area	1967-70 Share of Total Cultivated Land	1980-85 Area	1980-85 Share of Total Cultivated Land
	(million acres)	(percent)	(million acres)	(percent)	(million acres)	(percent)
Single-cropped	14.6	70.5	12.6	58.1	11.4	53.5
Double-cropped Triple-cropped	6.1	29.5	7.9	36.4	8.2	38.5
			1.2	5.5	1.6	7.5
Total cropped area	26.8	129.5	32.0	147.4	32.7	153.5

Sources: Based on data from Pakistan, Central Statistical Office, *25 Years of Pakistan in Statistics* (Karachi: Government Press, 1972); and Bangladesh, Bureau of Statistics, *Statistical Pocket Book of Bangladesh, 1986* (Dhaka: Ministry of Planning, 1987).

Note: Parts may not add to totals because of rounding.

slack agricultural seasons to augment the income from farming. The proportion of small farmers increased from about a half in 1960 to over two-thirds by 1983/84, and they now cultivate about a third of total land (see Table 5). During the same period, the proportion of large farmers declined from 11 to 5 percent and the area operated by them fell from two-fifths to one-fourth of total land. The above landholding characteristics imply that there are few farmers who can generate enough surplus for reinvestment in agriculture, particularly in indivisible assets such as irrigation equipment.

While land is extremely scarce, Bangladesh is known to have abundant water resources, for which planned use in agricultural production was almost nonexistent even by the early 1960s. Three major rivers, the Ganges, the Brahmaputra, and the Meghna, and their numerous tributaries flow through Bangladesh and discharge huge volumes of water. Heavy rainfall and the geological structure produce excellent supplies of groundwater, which is available up to a depth of about 12 meters in most regions and at less than 6 meters in large parts of the country, and hence can be developed at relatively low cost. The recently completed National Water Plan estimates that nearly 40 percent of the cultivated land can be irrigated by development of surface water

Table 5—Changes in distribution pattern of landholdings, 1960-83/84

Farm Size	Share of Holdings 1960	Share of Holdings 1983/84	Share of Area Operated 1960	Share of Area Operated 1983/84	Average Size of Farm 1960	Average Size of Farm 1983/84
(acres)	(percent)		(percent)		(acres)	
Less than 1.0	24.3	40.4	3.2	7.8	0.47	0.44
1.0–2.5	27.3	29.9	13.0	21.2	1.68	1.60
2.5–5.0	26.3	18.0	26.4	27.5	3.55	3.45
5.0–7.5	11.4	6.8	19.3	17.6	6.00	5.91
7.5 or more	10.7	4.9	38.1	25.9	12.60	11.85
All farms	100.0	100.0	100.0	100.0	3.54	2.26

Sources: Based on data from Pakistan, Agricultural Census Organization, *1960 Census of Agriculture* (Karachi: Government Press, 1962), vol. 2, *East Pakistan;* and Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Ministry of Planning, 1986).

through water conservation measures and withdrawing of streamflows from rivers.[17] The groundwater resource potential is estimated, on the basis of 75 percent usable recharge, at 17,140 million cubic meters, which can irrigate about 9.4 million acres, or about 45 percent of the cultivated land. Currently only about 20 percent of total land is irrigated. Obviously, there is a vast potential for further development of water resources in the country.

The new varieties of rice and wheat, developed by the international agricultural research stations and introduced to farmers in Bangladesh in the late 1960s, opened up the possibility of increasing the food supply on the limited land through development of water resources. The new varieties produce a substantially higher amount per unit of land compared with the traditional varieties, but they need careful water management and large amounts of chemical fertilizer, without which they fare no better than traditional varieties. Thus, production could be increased by shifting land from traditional to modern varieties (popularly known as "seed-fertilizer" technology), provided the land has access to flood control, drainage, and irrigation facilities. At the same time, expansion of irrigation facilities would increase the effective supply of land during the dry winter season when a large proportion of land is kept fallow because of inadequate moisture in the soil. The diffusion of new technology supported by the development of water resources is thus the key to maintaining the food-population balance in the country.

Diffusion of Modern Technology

The New Seeds

Experiments in the management of rice seed improvement have been conducted at the Dhaka Research Station since 1911, but a set of MVs was imported in the late 1960s to support the accelerated food production program sponsored by the Ford Foundation.[18] During the 1970s, large quantities of MV seeds were imported from the International Rice Research Institute (IRRI) in the Philippines and from India.

In 1970 the Bangladesh Rice Research Institute (BRRI) was set up to develop varieties better suited to local growing conditions. By 1983, BRRI had introduced 16 short-duration modern varieties. The newer varieties have yield rates similar to the earlier ones, but are superior in disease resistance ~~and grain quality. Rice is grown~~ in three distinct seasons: aus (April to August), aman (August to December), and boro (January to May). The new varieties have been introduced in all three seasons. In addition, a number of improved wheat varieties have been imported from the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) in Mexico and from India and have been propagated on the seed multiplication farms of the Bangladesh Agricultural Development Corporation (BADC) for distribution among farmers. The most popular wheat variety is Sonalika, which was bred in India with materials from CIMMYT and its predecessors based on Mexican material.[19]

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[17] Bangladesh, Master Plan Organization, *National Water Plan Project: Draft Final Report,* vols. 1 and 2 (Dhaka: Ministry of Irrigation and Flood Control, 1985).

[18] Dana G. Dalrymple, *Development and Spread of High Yielding Rice Varieties in Developing Countries* (Washington, D.C.: U.S. Agency for International Development, 1986), p. 39.

[19] Carl E. Prey and Jock R. Anderson, *Bangladesh and the CGIAR Centers: A Study of Their Collaboration in Agricultural Research,* Study Paper 8 (Washington, D.C.: World Bank, 1985), p. 43.

The official statistics on the expansion of area under modern seed varieties of rice and wheat are given in Table 6. The figures show that use of the new seeds was negligible up to the end of the 1960s, but picked up rapidly in the 1970-74 period, which was followed by stagnation during 1974-78. The expansion, however, resumed during 1978/79 and continued through 1984/85 at a rate of about 600,000 acres a year, which doubled the area covered by the new seeds within seven years.

The apparent stagnation in the MV area in the mid-1970s may be statistical rather than real. The Ministry of Agriculture set up task forces in 1974 and 1975 to evaluate the progress of MV aman and wheat programs, and their field investigations revealed substantial overreporting of MV aman acreage and minor underreporting of MV wheat acreage.[20] Recognizing that the early information on MV expansion was overreported, the Bangladesh Bureau of Statistics made substantial downward adjustments in the area under aman and boro MVs for 1974/75-1976/77.[21] In view of this adjustment it could be argued that the diffusion of new seed varieties has proceeded steadily since their introduction in the late 1960s.

By 1985 nearly one-third of the cereal area had been covered by the new seeds. Nearly two-thirds of the MV area is cropped during the overlapping boro and aus

Table 6—Expansion of area under modern-variety (MV) seeds, 1967-86

					Rice and Wheat MVs	
	Rice MVs					
Year	Boro Season	Aus Season	Aman Season	Wheat MVs	Total Area	Share of Total Rice and Wheat Area
		(1,000 acres)		(1,000 acres)	(1,000 acres)	(percent)
1967/68	156	...	...	...	156	0.6
1968/69	361	17	...	...	378	1.5
1969/70	580	43	29	...	652	2.5
1970/71	857	79	200	...	1,136	4.6
1971/72	793	121	625	...	1,539	6.7
1972/73	1,087	163	1,378	52	2,680	11.1
1973/74	1,455	329	2,043	72	3,899	15.8
1974/75	1,630	699	1,240	82	3,651	14.9
1975/76	1,588	872	1,376	217	4,053	15.7
1976/77	1,338	902	1,046	288	3,574	14.2
1977/78	1,586	981	1,233	388	4,188	16.6
1978/79	1,650	1,055	1,694	583	4,892	19.4
1979/80	1,788	994	2,154	1,015	5,953	22.7
1980/81	1,845	1,200	2,376	1,412	6,833	25.4
1981/82	2,218	1,166	2,361	1,277	7,022	25.8
1982/83	2,670	1,175	2,653	1,231	7,729	28.2
1983/84	2,635	1,235	2,628	1,475	7,973	28.3
1984/85	3,040	1,151	2,669	1,622	8,482	31.5
1985/86	2,998	1,191	2,906	1,291	8,386	31.0

Sources: Based on data from Bangladesh, Bureau of Statistics, *Yearbook of Agricultural Statistics,* various issues (Dhaka: Ministry of Planning, various years); and Bangladesh, Bureau of Statistics, *Monthly Statistical Bulletin of Bangladesh,* various issues.

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[20] Bangladesh Agricultural Development Corporation, *HYV Task Force Reports, 1974/75* (Dhaka: BADC, 1977).

[21] See Mahabub Hossain, "Foodgrain Production in Bangladesh: Performance, Potential and Constraints," *The Bangladesh Development Studies* 8 (Nos. 1 and 2, 1980): 39-70.

seasons, when the crops are grown with irrigation. About 97 percent of the area under wheat has been covered by MVs, which have expanded largely at the expense of minor dry season crops such as oilseeds and pulses. The MV wheat area, however, constitutes only 15 percent of the MV cereal area. For rice, the coverage is about 78 percent for the boro season, 16 percent for the aus season, and 20 percent for the aman season. A major constraint to expansion of the MV area during the aman season is that more than two-thirds of the area remains under deep water throughout the season and is not suitable for growing the dwarf MVs.

Development of Irrigation Facilities

Before modern irrigation was introduced in Bangladesh, cultivators used to irrigate boro paddy by lifting surface water through such traditional devices as swing baskets and *dhones.* The 1960 agricultural census estimated that in 1959/60 nearly 7 percent of the cultivated land received irrigation by these traditional methods, mostly concentrated in the depressed basins of Sylhet, Mymensingh, and Rajshahi districts, where surface water was available at a height of 1-2 meters below the field during the driest months of the year.[22] The subsequent development of modern irrigation has partly replaced these traditional sources of irrigation, and the area under traditional irrigation reportedly declined from about 1.5 million acres in 1970/71 to 0.9 million acres by 1984/85.[23]

The initiative for development of modern irrigation facilities had been taken by the government, since farmers were unwilling or unable to make large, lump-sum investments in irrigation equipment. The major constraint has been the small average size of farms and the fragmented holdings. During 1976-84 the government expenditure for development activities in the agricultural sector was Tk 7,720 million a year, of which Tk 3,200 million (42 percent) was spent for irrigation and flood control.[24] The projects were financed mainly with foreign aid.

The government's earliest approach to expansion of irrigation facilities was through construction of large-scale multipurpose irrigation, flood control, and drainage projects carried out by the Bangladesh Water Development Board (BWDB). A number of major projects built during the 1960s and 1970s have been largely successful in protecting coastal and river belt areas from saline-water intrusion and floods, but they played only a minor role in the irrigation development of the country. The area irrigated by such projects constitutes only about one-tenth of the total area irrigated in Bangladesh. The provision of irrigation through the BWDB projects has been costly, since both the capital and current costs are borne almost entirely by the government.[25]

Most irrigation development in Bangladesh has taken place through use of small-scale equipment such as low-lift pumps, deep tubewells, and shallow tubewells. Up to the mid-1970s, expansion followed upon subsidized rental to farmers' cooperatives of low-lift pumps with a capacity of 1-2 cubic feet per second (see Table 7). The number of pumps under operation rose quickly from about 3,000 in 1965/66 to about 35,000 by 1973/74, but expansion since then has been slow. In 1978/79 the government

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[22] Pakistan, Agricultural Census Organization, *1960 Pakistan Census of Agriculture,* vol. 1, *East Pakistan* (Karachi: Ministry of Food and Agriculture, 1962).

[23] Bangladesh, Bureau of Statistics, *Yearbook of Agricultural Statistics* (Dhaka: Ministry of Planning, 1982); and Bangladesh, Bureau of Statistics, *Monthly Statistical Bulletin of Bangladesh,* March 1986.

[24] At the 1984/85 official rate of exchange, US$1.00 = Tk 30.

[25] See Siddiqur R. Osmani and M. Abul Quasem, "Pricing and Subsidy Policies for Bangladesh Agriculture," Bangladesh Institute of Development Studies, Dhaka, 1985 (mimeographed), pp. 134-137.

Table 7—Development of modern irrigation facilities, 1960-85

	Units of Irrigation Equipment Under Operation			Area Irrigated by Modern Methods[a]		Total Area Irrigated	
Year	Low-lift Pumps	Deep Tubewells	Shallow Tubewells	Acres	Share of Cultivated Land	Acres	Share of Cultivated Land
		(thousands)		(thousands)	(percent)	(thousands)	(percent)
1960/61	1.4	. . .	. . .	62	0.3	1,433	7.0[b]
1965/66	3.4	. . .	. . .	200	0.9	n.a.	n.a.
1969/70	17.9	1.0	. . .	830	3.8	2,613	12.0
1973/74	35.3	1.5	1.0	1,501	7.2	3,201	15.3
1974/75	35.5	2.7	2.4	1,564	7.5	3,562	17.0
1975/76	36.4	3.8	4.0	1,606	7.6	3,458	16.5
1976/77	28.2	4.5	5.4	1,341	6.6	3,004	14.7
1977/78	36.7	7.5	12.3	1,951	9.4	3,223	15.8
1978/79	35.9	9.3	17.0	2,295	11.0	3,903	18.9
1979/80	37.4	9.8	22.4	2,638	12.6	4,226	20.3
1980/81	36.1	10.1	38.4	3,033	14.3	4,520	21.4
1981/82	38.2	11.5	66.5	3,626	17.1	5,076	23.9
1982/83	42.2	13.8	104.1	4,036	19.0	5,345	25.1
1983/84	43.7	15.5	109.7	4,313	20.2	5,432	25.4
1984/85	49.8	16.7	137.0	4,579	21.5	5,483	25.7

Sources: Based on data from Bangladesh Agricultural Development Corporation, *Annual Report,* various issues (Dhaka: Government Press, various years); Bangladesh, Ministry of Finance, *Bangladesh Economic Survey,* various issues (Dhaka: Government Press, various years); Bangladesh Agricultural Development Corporation, "Sale of Shallow Tubewells in the Northwest and South-eastern Districts of Bangladesh," BADC, Dhaka, 1984 (mimeographed); and Pakistan, Agricultural Census Organization, *1960 Census of Agriculture* (Karachi: Government Press, 1962), vol. 2, *East Pakistan.*

Note: n.a. means not available.

[a] Figures for shallow tubewells include those fielded by the Bangladesh Krishi Bank, as estimated in Bangladesh Agricultural Development Corporation, "Sale of Shallow Tubewells." The area irrigated as reported in this table exceeds the figure provided by the Bangladesh Bureau of Statistics because of this discrepancy, as the latter did not include the area irrigated by these shallow tubewells.

[b] For 1959/60, as estimated in Pakistan's 1960 agricultural census.

started selling pumps to individual farmers and cooperatives. The subsidy remains at about 30 percent of the procurement cost.[26]

The promotion of groundwater development started late, beginning in 1967/68, and moved at a slow pace through 1977/78. Initially, deep tubewells were rented to bona fide farmers' cooperatives, which formed groups of water-users with contiguous plots totaling at least 50 acres. The groups would bear the operation cost and pay a highly subsidized pump rental to BADC. Beginning in 1978/79, the government started selling deep tubewells to groups and private individuals at a subsidy of about 70-80 percent. The number of deep tubewells increased gradually from 800 in 1970/71 to about 4,500 by 1976/77 and then more rapidly to about 16,700 by 1984/85.

The spurt of expansion of irrigation, however, began in the mid-1970s with the promotion of small-capacity (less than 0.5 cubic foot per second) shallow tubewells. From the beginning, these were sold to farmers almost at cost, but most of the purchases were financed by loans from the Bangladesh Krishi Bank (agricultural development bank), a large proportion of which were not repaid. The sales of shallow tubewells increased rapidly during 1979-83 but have slackened since then. The tubewells now account for over half of the total irrigated area in the country.

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[26] Osmani and Quasem, "Pricing and Subsidy Policies," pp. 291-296.

The reasons behind the slowdown of the sales of minor irrigation equipment have not yet been investigated thoroughly. It is conjectured that the tightening of disciplines regarding recovery of institutional loans and reduction in farmers' cash income due to low prices of jute may be the major factors. Further expansion may also be constrained because relatively large farms that can afford private investment in irrigation equipment have already been covered, and the government will have to tackle the more difficult problem of organizing the small and medium farms into cooperatives. The 1983-84 agricultural census found that only 89,000 rural households owned more than 15 acres of land (the command area of a shallow tubewell), and according to a World Bank estimate, there are already more than 170,000 shallow tubewells in the country.[27]

Official statistics on the area irrigated by different methods are known to be of dubious quality. The figures provided by different agencies in charge of irrigation development are not consistent with the figures published by the Bangladesh Bureau of Statistics, which probably underestimates the area irrigated by shallow tubewells sold through the private sector by the Bangladesh Krishi Bank. It is also reported in a number of field surveys that some of the equipment sold to farmers may be used for nonagricultural purposes.[28] The margin of error, however, may not be very large, as the 1983-84 agricultural census estimates the irrigated area at 1.62 million acres, against the official estimate of the area irrigated by modern methods at 1.75 million acres for that year.

The time series data on irrigated land, compiled from the figures released by BADC, BWDB, and the Ministry of Finance, are represented in Table 7. Modern irrigation, though almost negligible through the late 1960s, has developed rapidly since 1977/78. Still, only about one-fourth of the cultivated area is irrigated and about one-fifth is irrigated by modern methods. The potential for further development of irrigation is thus considerable.

Economic analysis of various modes of irrigation conducted by the National Water Plan on the basis of (1) the observed cropping pattern and input-output coefficients, and (2) shadow prices of inputs and output, gives a rate of return on investment of 35 percent for large flood control, drainage, and irrigation projects and more than 90 percent for minor irrigation equipment.[29] The incentive for farmers to invest in small-scale irrigation equipment has also been examined by the National Water Plan, using a cash-flow analysis, at the existing terms of loans from the financial institutions. The analysis shows that individual farmers have enough incentives to invest in shallow tubewells and low-lift pumps, but for deep tubewells private investment is not financially feasible at existing terms. However, investment through cooperatives provides ample financial incentives.

In spite of high profitability, the government achieved only 25 percent of the planned targets for irrigation expansion during the First Five-Year Plan (1973-78), and 71 percent during the Second Five-Year Plan (1980-85). The major constraints to expansion of irrigation seem to be (1) poor financial capacity owing to the low income of the farmers, low tax-GNP ratio, and inability of the government to recoup the investment cost from the beneficiary; (2) low implementation capacity of public institutions, which often leads to time and cost overruns in project implementation; (3) differential pricing of water by BADC and BWDB and of different equipment by BADC, all of which may dampen private initiatives for investment; (4) high unit costs on account of variable inputs due to low-capacity utilization of equipment; (5) lack of proper zoning of areas suitable for different equipment, which may result in improper siting that leads to low-capacity utilization; and (6) organizational problems in forming cooperatives of water users.

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[27] Bangladesh, *Census of Agriculture and Livestock.*

[28] See, for example, M. Abdul Hamid, *Low-Lift Pumps under IDA Credit in South-East Bangladesh: A Socio-Economic Study,* Rural Development Studies, Series 12 (Rajshahi: Rajshahi University, Department of Economics, 1984).

[29] Bangladesh, *National Water Plan Project.*

Fertilizer Consumption

Although chemical fertilizers were introduced into Bangladesh in the 1950s, their application was mostly limited to tea gardens and government experimental farms until the early 1960s. With the objective of popularizing this new input to farmers, BADC, a parastatal organization established for procurement and distribution of modern agricultural inputs to farmers, started selling fertilizers to farmers at highly subsidized prices. It is estimated that in 1968/69 the average rate of subsidy was about 58 percent for urea and phosphate, and 67 percent for potash.[30] With rapidly increasing sales, the subsidy rates began to put a heavy burden on the government budget in the early 1970s. This burden, together with an increase in the procurement cost of fertilizers, led the government to reduce subsidies. By 1983/84 the budgetary subsidy was reduced to about 25 percent of the cost, and the economic subsidy valued at border prices was about 23 percent in that year.[31] At present, there is little subsidy on fertilizer. During 1972-84 fertilizer prices increased by 20 percent a year, compared with a 10 percent increase in the prices of crop output. Another policy change introduced since 1978 is the handing over of fertilizer distribution at the local level from BADC to private traders. Under the new system, traders can buy fertilizer from BADC sales centers at the government-fixed prices and sell it to farmers at a market-determined price. BADC still keeps control over procurement of fertilizers and distribution to primary sales points and, for that purpose, also plans supply to maintain adequate stocks.

The trend in consumption of fertilizers can be reviewed in Table 8. In 1960/61 consumption was almost negligible at less than 1 kilogram of nutrient per acre of sown area. By the end of the 1960s, consumption had increased to over 4 kilograms per acre and it tripled within the next decade to about 13 kilograms in 1979/80. After a brief period of stagnation during 1979-83, consumption picked up again from 1983 to 1985. Sales in 1984/85 reached 1.26 million metric tons[32] of fertilizers valued at about 5.3 percent of the value added in crop production. During 1970-85, the trend rate for growth of consumption was about 10 percent a year.

Time series data for fertilizer application on crops are not available for Bangladesh. Trends of use in different seasons could, however, be constructed from BADC sales figures, which are available by months. Fertilizer is applied on the main aman paddy crop from July to October, when no other fertilizer-using crops are widely cultivated. November to March is the fertilizer application season for various rabi crops such as

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[30] F. Kahnert et al., *Agriculture and Related Industries in Pakistan* (Paris: OECD Development Center, 1970).

[31] Raisuddin Ahmed, "Structure, Dynamics, and Related Policy Issues of Fertilizer Subsidy in Bangladesh," in Bangladesh Institute of Development Studies/International Food Policy Research Institute, *Fertilizer Pricing and Foodgrain Production Strategy in Bangladesh, Technical Annex* (Washington, D.C.: IFPRI, 1985).

[32] All tons referred to in this report are metric tons.

Table 8—Trends in consumption of chemical fertilizers, by season, 1960/61-1984/85

	Total Fertilizer Sales				Sales per Unit of Cropped Land	
Year	Aman Season	Boro Season	Aus Season	All Seasons	All Seasons	Boro Season
	(1,000 metric tons)				(kilograms of nutrients/acre)	
1960/61	20	13	16	49	0.9	2.6
1965/66	45	28	35	108	1.7	5.3
1970/71	109	130	70	309	4.6	15.2
1973/74	109	200	81	390	5.9	22.1
1975/76	139	234	92	465	7.0	24.1
1976/77	154	227	140	521	8.0	24.9
1977/78	207	325	195	727	10.9	33.0
1978/79	256	358	140	754	11.1	35.7
1979/80	252	424	179	855	12.5	37.6
1980/81	265	429	195	889	12.8	35.2
1981/82	291	392	160	843	12.1	30.9
1982/83	245	507	216	968	13.7	38.0
1983/84	267	629	233	1,129	16.1	47.3
1984/85	364	669	228	1,261	18.1	44.8

Sources: Based on data from Bangladesh Agricultural Development Corporation, *Annual Report,* various issues (Dhaka: Government Press, various years); and Bangladesh, Bureau of Statistics, *Monthly Statistical Bulletin of Bangladesh,* various issues.

potato, wheat, mustard, and sugarcane, and also for boro paddy, which is grown under irrigated conditions. Aus paddy and jute are treated with fertilizer from April to June. The constructed time series data on season-specific consumption of fertilizer, reported in Table 8, show that the major focus of growth of fertilizer consumption has been on the boro and rabi crops cultivated during the winter season. Most of the area under MVs is also cultivated during this season. These crops now account for about one-fourth of the sown area, but sales during the 1984/85 season accounted for over half of the total fertilizer sales in the country. The present application rate of fertilizer on boro season crops is about 3.5 times higher than that for all crops taken together (Table 8). It is estimated elsewhere[33] that the share of MV crops in total fertilizer consumption increased from about 25 percent in 1969/70 to over 61 percent in 1983/84. Of the total increase in consumption during 1977-84, 81 percent was associated with the increased use of MVs and 51 percent with increased use on irrigated land. Thus MV seeds and irrigation have played an increasingly important role in the growth of fertilizer consumption in Bangladesh.

Complementarity of the Modern Technology Package

The time series data reviewed above show a high degree of complementarity between irrigation, fertilizer use, and diffusion of MV seed (Figures 2 and 3).[34] But

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[33] Mahabub Hossain, "Fertilizer Consumption, Pricing and Foodgrain Production in Bangladesh," in BIDS/IFPRI, *Fertilizer Pricing,* pp. 149-150.

[34] This section draws heavily from Mahabub Hossain, "Irrigation and Agricultural Performance in Bangladesh: Some Further Results," *The Bangladesh Development Studies* 14 (No. 4, 1986): 39-56. The main conclusions are also supported by James K. Boyce, "Water Control and Agricultural Performance in Bangladesh," *The Bangladesh Development Studies* 14 (No. 4, 1986): 1-35.

Figure 2—Expansion in modern irrigation and modern-variety seeds, 1960-84

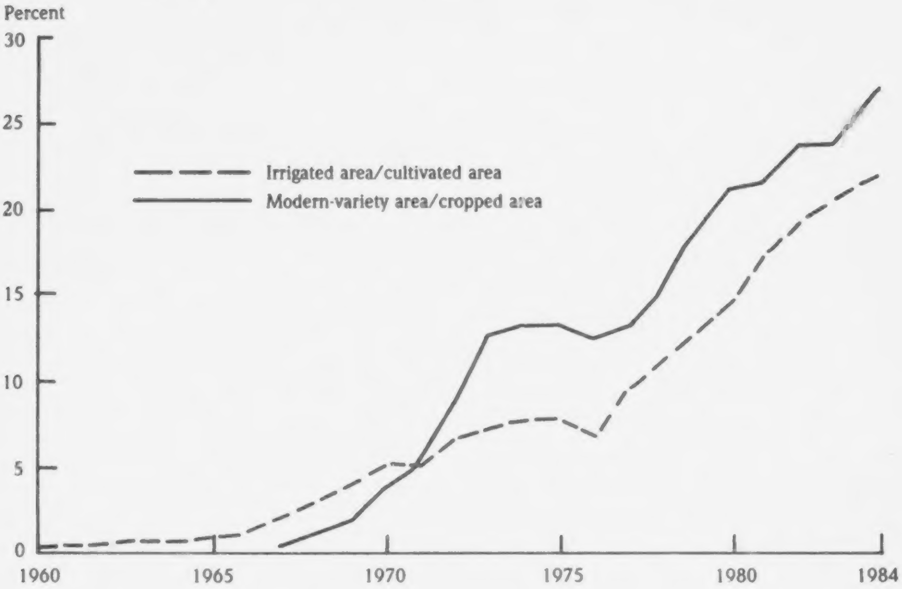
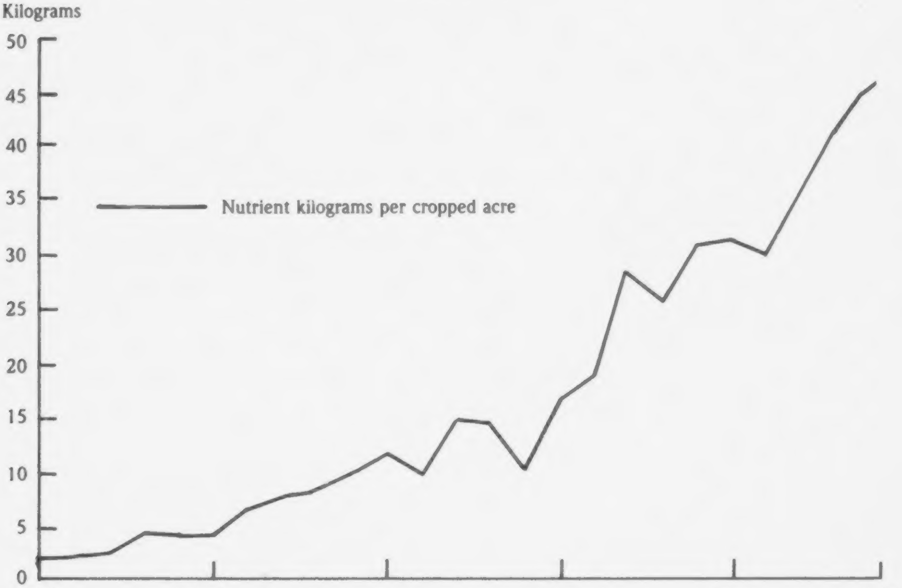


Figure 3—Trend in fertilizer use, 1960-84



irrigation could be the leading input in the sense that adoption of MVs and application of fertilizers follow development of irrigation facilities. The following analysis based on regional cross-section data for 1983/84, the latest normal year for which data are available, shows the nature of this complementarity and the leading role of irrigation.

A large variation in the diffusion of the new technology is found among the regions of Bangladesh. By 1984/85 the proportion of land irrigated by modern methods had increased to over one-third in the districts of Bogra, Kushtia, and Chittagong, while it was still less than 15 percent in the coastal districts of Patuakhali, Barisal, Khulna, and Noakhali. Similarly, the proportion of cereal area cultivated with MV seeds varied from 75 percent in Chittagong to less than 20 percent in Patuakhali, Barisal, Khulna, and Sylhet. Fertilizer consumption per acre of cultivated land varied from over 40 kilograms in the districts of Chittagong, Bogra, and Kushtia to less than 10 kilograms in the districts of Patuakhali, Barisal, Khulna, Faridpur, and Sylhet.

The relationship between the intensity of fertilizer consumption and the percentage of net sown area irrigated is shown by regression equations in Table 9, estimated by the ordinary least square (OLS) method on the district-level cross-section data. To reduce specification errors, important structural factors that differ across districts, such as annual rainfall, land elevation, and average farm size, have been used as additional

Table 9—Association of fertilizer consumption and adoption of modern varieties (MVs) with irrigation, 1983/84

	Regression Coefficient of Independent Variables						
		Share of Cultivated Area Irrigated					
Dependent Variables	Constant Term	Total	Modern Methods	Rainfall Deviation from Normal[a]	Share of Medium-High Land	$\bar{R}^2$	'F' Statistics
		(percent)			(percent)		
Fertilizer consumption (kilograms per acre)	8.27	5.81	...	−0.22	−0.54	0.60	10.5
	(0.43)	(5.31)		(−0.29)	(−1.57)		
	7.74	...	6.07	−0.30	0.11	0.77	21.7
	(0.54)		(7.71)	(−1.18)	(0.20)		
	5.77	...	5.87	...	...	0.79	65.8
	(0.83)		(8.11)				
Percent of cultivated area under dry-season MVs (boro rice and wheat)	5.82	0.86	...	−0.07	−0.03	0.67	14.1
	(1.79)	(5.92)		(−1.52)	(−0.26)		
	5.88	...	0.89	−0.03	−0.04	0.82	30.5
	(1.31)		(8.83)	(−1.02)	(−0.61)		
	2.44	...	0.89	...	...	0.83	93.2
	(1.12)		(9.65)				
Percent of cultivated area under wet-season MVs (aus plus aman)	22.71	...	0.49	0.16[a]	−0.09	0.41	5.4
	(−1.69)		(1.92)	(3.16)	(−0.47)		
	22.71	...	0.53	0.15[a]	...	0.44	8.4
	(−2.27)		(2.28)	(3.23)			

Notes: Estimates are from district-level data. The sample size is 20 Bangladesh (old) districts. Figures in parentheses are estimated t-values.

[a] The variable is measured by the amount of annual rainfall in the district.

explanatory variables. The farm size variable was found to be statistically insignificant in all estimating equations and hence it was dropped. Since both too much and too little rainfall can affect fertilizer use, the absolute deviation of rainfall in the district from normal rainfall in Bangladesh has been used. The land elevation variable has been measured by the percentage of area under medium-high land in the district, as recorded in the 1977 agricultural census.[35] Two alternative irrigation variables have been used—total area irrigated and area irrigated by modern methods. Although most of the data are now available for 1984/85, the reference year for this analysis is 1983/84, which was chosen because the 1984/85 aus and aman crops were affected by a number of abnormal floods during July-September 1984, while 1983/84 was a relatively normal year.

The estimated equations show that the structural factors (rainfall and land elevation) do not influence fertilizer consumption or adoption of MVs during the dry season. Both these variables are, however, strongly correlated with the level of irrigation. A better statistical fit is obtained with modern irrigation than with traditional irrigation. This is expected because traditional irrigation is practiced mostly in the depressed basins of the country and is the outcome of the natural endowment of land and water rather than of a conscious investment decision by the farmer or the state. The low-lying areas remain unsuitable for growing any crop during the monsoon season and are used for growing local boro during the dry season when the water level is reduced, but deep flooding still does not allow adoption of MVs or economic use of fertilizer.

The estimated equations that contain only the statistically significant variables show that irrigation alone explains about 79 percent of the regional variation in fertilizer consumption and about 83 percent of the variation in diffusion of MVs during the dry season. The elasticity of fertilizer consumption in relation to irrigation is estimated from the equation at 0.90 at the mean level of use of these inputs, and the elasticity of MV adoption during the dry season is estimated at 0.89.

The area covered by MVs during the wet season is, however, more strongly associated with rainfall than with irrigation. Only about 44 percent of interdistrict variation in the coverage of MVs during the wet season is explained by these two variables. It appears that some other important determinants have not been incorporated in the analysis. One such variable may be the duration of the monsoon, since an early monsoon would facilitate adoption of aus MVs, and districts receiving adequate rainfall during the late monsoon period (September-October) may have a relative advantage in growing rain-fed aman MVs. The depth of flooding may be another variable.

The relatively weak relationship between irrigation and expansion of wet season MVs may be due to the initial spreading of MVs in districts that have favorable rainfall endowments and to the low-lift pump irrigation initially spread to low-lying areas where adequate surface water is available in the dry season, but deep flooding of such land during the wet season does not permit raising dwarf MVs. With increased extraction of groundwater resources by tubewells, irrigation facilities are now being extended to medium-high and high land areas, which could be used for providing supplementary irrigation required for raising MV aus and aman crops.

Development and use of modern irrigation facilities require prior capital investment and institutional arrangements for the coordination of actions among many cultivators. The adoption of MV seeds and application of chemical fertilizers are, however, current production decisions undertaken by individual cultivators. These special attributes of irrigation and the high degree of complementarity among the seed-water-fertilizer inputs in the new technology package suggest that development of irrigation poses the key constraint to diffusion of modern technology in Bangladesh. (This is discussed further in Chapter 6.)

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[35] Bangladesh, *Report on the Agricultural Census, 1977.*

Impact on Growth

What has been the impact of technological progress on the growth of crop production? This section analyzes the official time series data on sown area and production of different crops for 1950-85 to see whether production growth has accelerated since the introduction of the new agricultural technology.

A large number of crops are grown in Bangladesh, but three crops—rice, wheat, and jute—account for nearly 90 percent of the total sown area. This analysis considers rice and wheat (cereal group), and jute, sugarcane, tobacco, pulses, oilseeds, potato, and chili (noncereal group). These crops accounted for about 94 percent of the sown area during 1980-85, so the exclusion of other crops should not seriously affect the results. The 1981/82 crop-level harvest prices have been used as weights for valuation of production at constant prices. In Bangladesh, prices fluctuate widely from year to year, particularly for minor crops, whose production is highly responsive to changes in relative prices.[36] The 1981/82 price level was chosen because, for most of the crops, it was very close to the trend for 1976-84.

The yield rates have been estimated by dividing the gross value of production by the sown area. To assess the impact of the new technology on growth, the time series has been divided into two parts, 1950-71 and 1971-85, and the growth performance of the two periods has been compared (see Figure 4). The crop year 1971/72 has been taken as the dividing line because, as noted earlier, little progress was made with the new technology through the late 1960s and, also, Bangladesh became independent of Pakistan in 1971 and a close scrutiny of the official series indicates that a downward adjustment has been made since 1971/72 in the crop-yield figures.

To see whether the growth rate has accelerated since 1971/72 with the diffusion of the new agricultural technology, the following trend equation has been fitted on the data for the entire period (1950-85):

$$\mathrm{Ln}Y = a_0 + a_1D + b_0T + b_1DT + u,$$

where Ln is the natural logarithm of the variable, Y is the variable for which the rate of growth is estimated, D is the dummy variable, taking value one for 1971-85 and zero otherwise, and T is time. The rate of growth for 1950-71 is given by b_0 and that for 1971-85 is given by $(b_0 + b_1)$. The value of b_1 is expected to be positive if there has been an acceleration of growth during 1971-85. The coefficient of the dummy variable, a_1, will indicate whether any adjustment has been made in the time series since 1971.

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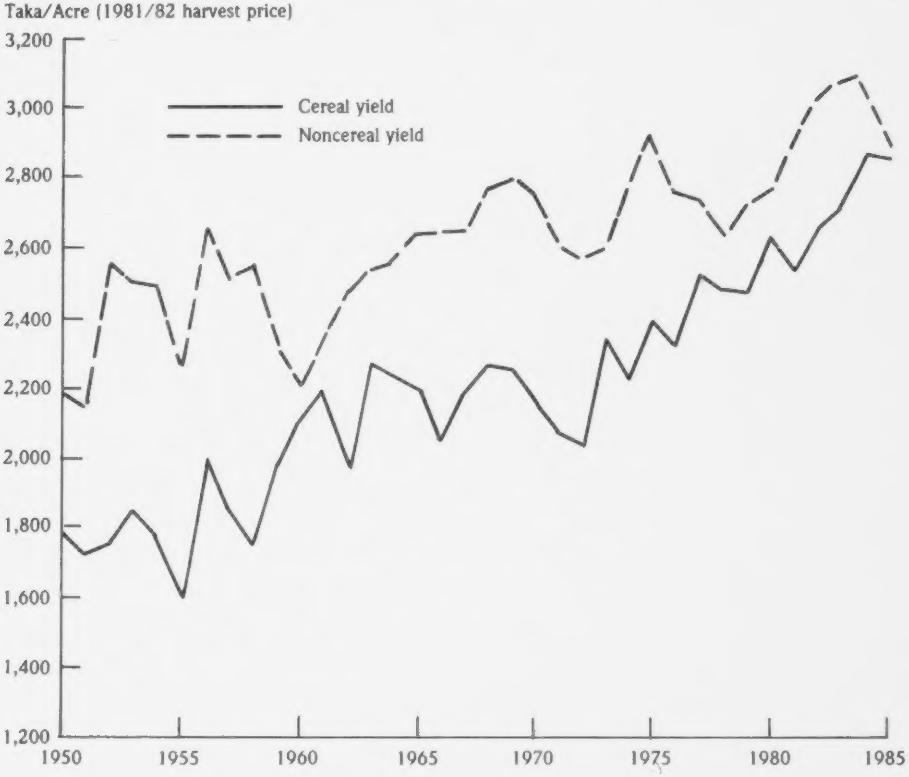
[36] John T. Cummings, "The Supply Response of Bangalee Rice and Cash Crop Cultivators," *The Bangladesh Development Studies* 2 (October 1974): 235-251; and Sultan H. Rahman, "Supply Response in Bangladesh Agriculture," *The Bangladesh Development Studies* 14 (No. 4, 1986): 57-100.

Figure 4—Trends in yield of cereal and noncereal crops, 1950-85



The growth rates derived from the estimated equations (see Appendix, Table 72) are presented in Table 10. The growth of production has accelerated from about 2.5 percent a year during 1950-71 to about 2.9 percent during 1971-85. This has taken place in spite of a deceleration in the growth of cropped land in the later period. The impact of technological progress should be felt on the growth of land productivity. It is estimated that the growth of yield rates has accelerated from 1.4 to about 2.0 percent a year for all crops. The acceleration coefficient is found to be statistically significant at about 5 percent probability level.

For investigation of the issue at hand, cereals are more important than noncereals, since technological progress has taken place mainly in the production of rice and wheat. The production of cereals has grown at faster rates than production of noncereal crops, and the difference in performance is particularly noticeable in the postmodern-technology period. The growth of production for cereal crops has accelerated from about 2.6 percent a year during 1950-71 to about 3.4 percent during 1971-85. The acceleration in production is mainly on account of the growth in crop yields, that is, land productivity, which has increased from 1.5 to 2.2 percent a year. The acceleration in the growth of productivity in the postmodern-technology period is almost twice as much for cereals

Table 10—Growth in crop production before and after introduction of modern technology

Crops/Period	Trend Rate of Growth Cropped Land	Yield per Unit of Land	Production
		(percent/year)	
Cereal			
1950-71	1.10	1.52	2.62
1971-85	1.16	2.20	3.36
Noncereal			
1950-71	1.26	0.89	2.15
1971-85	−0.73	1.26	0.53
All			
1950-71	1.12	1.40	2.52
1971-85	0.90	2.02	2.92

Source: Derived from equations in Table 72, based on estimates from official statistics from Bureau of Statistics, Bangladesh.

as for noncereal crops. The acceleration coefficient for cereal yield is found to be statistically significant at 10 percent probability level.

The technological progress in cereal crops, however, has had adverse effects on the production of noncereal crops, many of which cannot compete with MVs of rice and wheat. The most seriously affected crops are jute, pulses, and oilseeds, whose cultivated area has declined consistently since the late 1960s. Jute competes for land with aus rice, but owing to a long-term decline in the price of jute relative to the price of rice, large fluctuation in its prices, and technological advances made in rice, some of the traditional jute land has been shifted to MV aus and boro crops. The expansion of cropped land under boro rice and wheat has been partly at the expense of pulses and oilseeds. It will be noted from Table 10 that cereal crops have maintained their growth in cropped land at about 1.1 percent a year, largely at the expense of noncereal crops, whose cultivated area declined absolutely at a rate of about 0.7 percent a year during 1971-85.

Level and Fluctuation of Food Prices

Technological progress implies a downward shift in the cost function (Chapter 4), and depending on the nature of demand, some of the benefits may be shifted to consumers in the form of lower prices. It is argued in the literature that one of the important ways through which technological progress indirectly benefits the poor is the lowering of real food prices.[37] So a relevant empirical question at this point is what has happened to the prices of cereals compared with those of noncereal crops since the introduction of modern technology.

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[37] See Mellor, "Food Price Policy and Income Distribution"; and Yujiro Hayami and Robert W. Herdt, "Market Price Effects of Technological Change on Income Distribution in Semi-Subsistence Agriculture," *American Journal of Agricultural Economics* 59 (May 1977): 245-256. For Bangladesh the issue has recently been studied by Mohammad Alauddin and Clem Tisdell, "Market Analysis, Technical Change, and Income Distribution in Semi-Subsistence Agriculture: The Case of Bangladesh," *Agricultural Economics* 1 (No. 1, 1986): 1-18.

Table 11 presents estimates of the rate of increase in the retail prices of major commodities in the consumption basket for 1950-71 and 1971-85. Since prices fluctuate considerably from year to year, the rates of growth have been estimated by fitting semilogarithmic trend lines to the time series data. The rate of inflation, as measured by the trend rate of growth in the consumer price index, was only about 3 percent a year during the 1950s and 1960s but increased to about 11 percent after independence. So in comparing price changes for the two periods, the relative increase in prices, rather than the absolute increase, should be examined.

During the two decades before the introduction of the new technology, rice prices increased at a much faster rate (80 percent higher) than the general rate of inflation in Bangladesh. In fact, among the major commodities in the consumption basket, the price of rice increased at the fastest rate. This position, however, was completely reversed in the postmodern-technology period, when the prices of rice increased at the same rate as the general rate of inflation in the country.[38] Some of the commodities, such as pulses, beef, and fish, which experienced slower rates of increase in prices than did rice during the earlier period, had price increases at 10 to 50 percent higher rates than rice during the later period. Only for oil, gur (raw sugar), and potato did prices continue to increase at a slower rate. The lower prices for oil and gur may have been maintained by the government by importing substitute commodities, soybean oil,

Table 11—Changes in food and nonfood consumer prices before and after introduction of modern technology

	1950-71			1971-85		
Commodity	**Rate of Increase**	**Standard Error of Estimate**	**Instability Index**	**Rate of Increase**	**Standard Error of Estimate**	**Instability Index**
	(percent/year)		(percent)	(percent/year)		(percent)
Food						
Rice	5.42	0.47	12.9	10.98	0.76	9.0
Pulses	3.89	0.47	12.8	12.16	1.47	14.5
Potato	1.05	0.47	12.2	5.56	1.40	15.8
Gur (raw sugar)	3.51	0.59	17.0	8.99	1.24	14.1
Fish	2.32	0.58	15.8	16.56	1.93	13.6
Beef	3.86	0.27	7.6	16.17	2.51	16.9
Oil	3.43	0.55	15.5	8.89	0.82	9.6
Nonfood						
Firewood	4.98	0.49	14.0	10.98	0.68	9.0
Textiles	1.52	0.58	13.8	9.21	0.66	5.7
Consumer price index	2.95	0.20	5.5	10.99	0.59	6.8

Source: Estimated by fitting semilogarithmic trend lines on time series.

Notes: The retail prices are reported for major urban centers in Dhaka, Chittagong, Khulna, Rajshahi, Sylhet, and Rangpur. The figures in the table are based on the series for Dhaka. The consumer prices are for laborers in the industrial city of Narayangong. The year 1974/75, when famine conditions prevailed in the country, was excluded in estimating trends for the later period.

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[38] Since rice is a major commodity in the consumption basket, it may be argued that the movement in the cost-of-living index is mainly determined by the rice prices. According to a 1983-84 survey, rice accounted for 32 percent of the national consumption expenditure, so the rice price index and the CPI may not necessarily increase at the same rate. See Bangladesh, Bureau of Statistics, "Report of the Bangladesh Household Expenditure Survey, 1983-84," Ministry of Planning, Dhaka, 1987 (mimeographed).

and sugar and by distributing them to urban consumers through the rationing system, and also by controlling the price of sugar produced in government-owned mills. Potato is the only noncereal food for which the long-run growth in production has been faster than for cereals. The growth rate is estimated at 8.2 percent for 1950-84 and 3.5 percent for 1971-85.

A general problem with agricultural prices in Bangladesh is that they are very unstable. The new crop varieties are less dependent on weather than the traditional ones, as the land on which they are grown generally has access to irrigation facilities. So with a large proportion of cereal production coming from the new varieties, the weather-induced fluctuations in production and prices are expected to be reduced.[39] Table 11 also presents a measure of the instability of consumer prices for the periods before and after introduction of the new technology. Following Cuddy and Della Valle,[40] the instability index is derived as follows:

$$I = CV/(1 - \bar{R}^2),$$

where I is the index (percent), CV is the coefficient of variation (standard deviation as a percentage of arithmetic mean), and $\bar{R}^2$ is the adjusted coefficient of determination of the semilog trend function. It will be noted from the estimates that although the rate of inflation has increased by over three times in the postmodern-technology period, the instability index has not changed much. In general the prices are more unstable for noncereal food crops than for cereals. This has been the experience particularly in the postmodern-technology period, when prices of important food crops such as potato and pulses have been more unstable than they were during the earlier period. For rice, in which the technological progress has taken place, the degree of instability has been reduced; the index went down from about 13 percent for 1950-71 to 9 percent for 1972-85.

The slowing of the increase in real prices of rice, and its greater stability in the postmodern-technology period, may not be entirely due to technological progress. Changes in the government's monetary and fiscal policy can influence these variables. More important, the government has followed a price-intervention policy for rice, declaring support prices and participating in markets through procurement after harvests, and distributing cereals directly to consumers through various channels. The effect of technological progress can only be worked out after dissociating the effect of these other factors, which in itself is an important topic of research and has not been pursued in this study.

Conclusions

In Bangladesh, agricultural growth is constrained by limited availability of land. The amount of cultivated land has not increased since the early 1950s. At present the wasteland that can be reclaimed for cultivation is only about 2 percent of total land. But Bangladesh has vast water resources that can be developed for adoption of modern rice technology to increase foodgrain production. In fact, the country has maintained the food-population balance since its independence in 1971 mainly through technological progress. About one-fifth of cultivated land has been brought under modern irrigation, mostly through public investment. This, together with improved flood control and drainage, has made possible an expansion of MVs to about one-third of the sown area under cereals and an increase in fertilizer consumption from 4.5 to 18.2 kilograms of nutrients per acre during 1971-85. The growth of cereal production has accelerated from 2.6 percent a year during 1950-71 to 3.4 percent during 1971-85, mostly due to acceleration in the growth of crop yields. The productivity growth may have been one of the factors that has helped to keep rice prices low. The retail price of rice, which increased at a rate about 80 percent faster than the cost-of-living index during 1950-71, has moved at par with the general rate of inflation during 1971-85. There is still vast potential for further diffusion of the new technology, whose rate of exploitation may depend on the government's undertaking appropriate policies.

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[39] In India, instability in cereal production increased greatly in the post-new technology period. Hazell, however, shows that about 82 percent of the increased variation can be attributed to increases in the covariances of production between crops grown in the same state and in different states—a development that cannot be blamed on improved technologies. Only 6 percent of the variances of total cereal production was attributed to variances of individual crop yields measured at the state level. See Peter B. R. Hazell, *Instability in Indian Foodgrain Production*, Research Report 30 (Washington, D.C.: International Food Policy Research Institute, 1982).

[40] J. D. A. Cuddy and P. A. Della Valle, "Measuring the Instability of Time Series Data," *Oxford Bulletin of Economics and Statistics* 40 (February 1978): 79-85.

4

NATURE OF ALTERNATIVE RICE TECHNOLOGIES

The term "technology" is generally used to mean the application of knowledge to produce output through optimum use of combined inputs. The new technology would thus mean a change in the combination of inputs and in their amounts and methods of application. It is important to understand the nature of these changes, because in underdeveloped agriculture, where endowments and real costs of resources vary across farms, the suitability and acceptance of the new technology depend on these changes.[41]

This chapter documents in detail the characteristics of the alternative crop technologies currently in use in Bangladesh and their implications for cost of production, capital requirements, profitability of cultivation, and returns to family resources. The information is drawn mainly from the farm household survey conducted by the International Fertilizer Development Center (IFDC) from aman 1979 through boro 1982 seasons[42] and is supplemented by the information collected by the Bangladesh Institute of Development Studies/International Food Policy Research Institute (BIDS/IFPRI) survey.[43] The IFDC survey is the largest household survey ever conducted in Bangladesh, covering 2,400 randomly selected households from 16 out of 21 Bangladesh (old) districts. The input-output information on crops was collected for about 10,000 sample plots belonging to the selected households. Since the farmers do not keep any records of their operations, the input-use information collected at the plot level tends to be more reliable than those collected at the farm level. The findings of this study are expected to be representative for the country as a whole, and the degree of accuracy is as much as can be obtained by asking questions of the farmers.

As noted earlier, technological progress in Bangladesh is mainly confined to production of rice and wheat. Wheat was an unimportant crop even up to the mid-1970s, but a rapid increase in wheat area since 1975/76 has turned it into the third major crop after rice and jute. Wheat now occupies about 5 percent of total cropped land, most of it under MVs. The scope for further expansion is limited, however, because the soil and the duration of the winter season in Bangladesh are not very suitable for production of wheat. Rice occupies nearly four-fifths of the sown area in the country and is grown in three seasons. The monsoon rice, aman, harvested from November to January, accounts for about 46 percent of cropped land and 58 percent of rice land. About one-fourth of aman land is broadcast-seeded (deep-water variety), sown in March when the land is dry and harvested in November and December when the water recedes. On this type of land the depth of flooding prevents raising any other crop during the monsoon season. On the remaining aman land (medium-low and medium-high elevations) the crop is transplanted, and the MVs have spread to about one-fourth of the area. The early monsoon rice, aus, harvested in July and August, consists mostly of broadcast varieties sown in March-April on either very low or very high land. In some areas transplanted rain-fed aus varieties are also grown.[44] This crop traditionally competes with jute and now accounts for about one-fourth of the total sown area in the country. MVs have spread to about one-sixth of the aus land and have tended to remain at that amount since the late 1970s. Aus MVs are mostly transplanted, but in some areas broadcast MVs are also grown. The remaining one-sixth of rice land is under boro, which is grown under irrigation, transplanted during December-February, and harvested in April-June. The major impact of the new technology has been on this boro rice crop. The cropped area increased from 1.56 million acres in the late 1960s to about 3.89 million acres by 1984/85, facilitated by expansion of modern irrigation. Nearly four-fifths of the area under this crop is now under MVs. The traditional boro is grown on extremely low-lying land that is unsuitable for growing any crop during the monsoon season because of severe flooding. Boro MVs are grown on relatively high land. Since boro and aus seasons overlap, boro MVs compete with aus and jute, whose cropped area has declined steadily in recent years, and there is further possibility of substituting boro MVs for aus crops. The exclusive focus on alternative rice technologies in this chapter is dictated by the importance of rice and the great potential for expansion of the area under MVs.

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[41] Pears, *Seeds of Plenty.*

[42] International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations.*

[43] BIDS/IFPRI, *Development Impact.*

[44] See Noel P. Magor, *Potential in Rainfed Transplanted Rice Production in North-East Bangladesh* (Dhaka: Bangladesh Rice Research Institute, 1984), p. 32.

Amount and Fluctuation of Crop Yield

Bangladesh has little scope for increasing the supply of land (Chapter 2). Even an individual farmer who has the means to accumulate more land finds it difficult to do so, because in the absence of adequate nonagricultural job opportunities, rural people tend to cling to their holdings and the market for land tends to be thin. So, for both the nation and the individual farmer, the only scope for increasing production is through increased cropping intensity or increased crop yield. A new crop variety that has intrinsic capacity to produce more per unit of land would thus be widely accepted. It would provide the means to increase production from the limited land base through reallocation of land from traditional to new varieties.

Table 12 presents the findings of the two surveys on yield rates (output per unit of land) for the alternative crop varieties and compares them with the official statistics for the entire country. Since yields vary considerably from year to year, the figures are presented as averages for a number of years, which should give a relatively normal picture. The IFDC survey estimated the yield for three years, from 1979/80 to 1981/82, and the BIDS/IFPRI survey for two years, 1981 and 1982. The survey estimates are very close to the official statistics, which support the representativeness of the surveys. The MVs produce more output per unit of land than do the traditional varieties in all three seasons: about one and a half times higher during the aus season, three-fourths higher during the boro season, and one-half higher during the aman season. On average, the yield of the new varieties is about 100-120 percent higher than the yield of traditional ones. Diffusion of the new technology thus contributes to a substantial increase in rice production from the limited land.

A large majority of farmers in Bangladesh operate around or below the subsistence level, so they may respond not only to the average yield but also to the fluctuations in yield, thus making investment in agricultural inputs a risky venture. Being risk-averse, a farmer may be willing to sacrifice a substantial amount of expected income—as indicated by higher mean value of output in the MVs—in exchange for a low probability of falling below the subsistence level. The new crop varieties are less dependent on weather than are traditional ones, since the land has access to irrigation facilities, and during the monsoon season they are generally grown on higher land, which is less

Table 12—Estimates of crop yield for traditional and modern varieties of rice

Season/Variety	Weight[a]	IFDC Survey	BIDS/IFPRI Survey	Government Statistics
		Annual Average, 1980-82	Annual Average, 1981 and 1982	Annual Average, 1982-85
			(tons of paddy/acre)	
Aus (early monsoon)				
Traditional	0.180	0.53	0.48	0.50
Modern	0.037	1.28	1.31	1.32
Aman (monsoon)				
Traditional, broadcast	0.103	0.62	0.69	0.61
Traditional, transplanted	0.265	0.77	0.70	0.75
Modern, transplanted	0.089	1.11	1.16	1.17
Boro (dry winter)				
Traditional	0.026	0.79	1.01	0.93
Modern	0.094	1.51	1.51	1.66
All seasons[b]				
Traditional	0.574	0.67	0.65	0.65
Modern	0.220	1.31	1.33	1.41
			(percent)	
Difference in modern over traditional	. . .	96	105	117

Sources: International Fertilizer Development Center survey and Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey. Government statistics are based on data from Bangladesh, Bureau of Statistics, *Monthly Statistical Bulletin of Bangladesh*, various issues.

[a] The area under the variety as a proportion of the total cropped area during 1985 for the country as a whole.

[b] Weighted averages.

susceptible to floods. So the weather-induced fluctuation in production is expected to be low for the new varieties. However, they may be more susceptible to pest attacks, and the risk of crop damage on that account is expected to be higher. Also, for rain-fed MVs (for example, aman MVs) water stress may reduce the yield more than in the case of a local variety.[45]

The estimates of variation in crop yields could not be obtained, as primary information from the IFDC survey was inaccessible. The estimates obtained from the plot (1981) and farm (1982) data collected by the BIDS/IFPRI survey are presented in Table 13. The estimates of variation are expected to be lower at the farm level than at the plot level, as the fluctuation is reduced by summing over the data for a number of plots that the farm operates. In 1981, for which the estimates are obtained from the plot data, the standard deviation of yield as a percent of the arithmetic mean is found to vary between 32 and 78 percent.[46] But the magnitude of variation is, in general, lower for the MVs. For MV boro and aman it is about 48 percent, and for aus, 32 percent, compared with 69 percent for traditional aman and 78 for traditional aus. For 1982 also, the magnitude of variation is lower in MVs for the aus and aman seasons and is

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[45] Magor found that a substantial reduction in rainfall in 1981 over 1980 reduced the yield of modern aman varieties by 30 percent, while the reduction in yield of local varieties was 25 percent. See Magor, *Rainfed Transplanted Rice Production*, p. 32.

[46] Cropping system research in an upazila in Sylhet District found that for the aman crop, 62 percent of the yield variation in 1981 was attributable to transplanting date and water stress. The yield loss per water-stress day was estimated at 75 kilograms per hectare for MVs, compared with 48 kilograms per hectare for a local variety. See Magor, *Rainfed Transplanted Rice Production*, p. 2.

Table 13—Variation in yield for traditional and modern varieties of rice, 1981 and 1982

	1981 Plot Data				1982 Farm Data			
Season/Variety	Number of Plots	Mean Yield	Standard Deviation	Coefficient of Variation	Number of Farms	Mean Yield	Standard Deviation	Coefficient of Variation
		(metric tons/acre)		(percent)		(metric tons/acre)		(percent)
Aus								
Traditional, broadcast	584	0.53	0.41	78	152	0.45	0.22	48
Modern, transplanted	281	1.26	0.40	32	86	1.38	0.26	19
Aman								
Traditional, broadcast	379	0.73	0.40	55	144	0.65	0.29	45
Traditional, transplanted	789	0.69	0.48	69	179	0.73	0.50	69
Modern, transplanted	634	1.05	0.51	49	159	1.26	0.77	61
Boro								
Traditional, transplanted	231	1.09	0.69	63	94	0.93	0.33	35
Modern, transplanted	765	1.38	0.66	48	204	1.62	0.65	40

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

similar for the boro season. The boro crop was severely affected by hailstorms in April 1982 in two of the villages where MV boro is a major crop.

For 1982, information was also collected from farmers about the extent of crop damage from natural factors. During that year the aus crops were affected by drought in the villages in Kushtia and Jessore, the aman crops were affected by a flash flood in two villages in Comilla, and the boro crops were affected by hailstorms in two villages in Dhaka and one village in Comilla. Each farmer was asked to report the percentage by which the actual yield was lower than the expected yield, given the application of inputs. The response is subjective, but comparison of the figures for traditional and modern varieties would indicate the direction of change. The findings also show a high degree of crop damage, but it is lower for MVs than for traditional varieties of aus and aman (Table 14). For the boro season, however, the damage is reported to be lower for traditional varieties.

Table 14—Farmers' perception of extent of crop damage, 1982

	Traditional Variety		Modern Variety	
Season	Arithmetic Mean	Standard Error	Arithmetic Mean	Standard Error
	(percent of expected yield)			
Aus	45	2.2	32	2.6
Aman	38	2.0	33	2.1
Boro	21	2.6	28	2.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Use of Inputs

Family and Hired Labor

The estimates of labor input used per acre of land in operation under different technologies, as obtained from the IFDC survey, are presented in Table 15. The survey collected this information at the plot level for all seasons from aman 1979 to boro 1982. The figures in the table are averages for the three years' estimates. The following features emerge from the table.

Farmers use more labor per unit of land in MVs than in traditional varieties in all three seasons. The increase is about 41 percent for the aus season, 38 percent for the aman season, and 6 percent for the boro season. For all three seasons together, labor use per acre is about 47 percent higher under the MVs.[47] The diffusion of the new technology will thus create more employment from the limited land base through reallocation of land from traditional to modern varieties.

The new varieties, however, economize on labor needed to produce a given amount of output. The amount of labor used to produce a ton of paddy was about 57 eight-hour days for the new varieties, compared with 85 days for the traditional crops. Thus unit cost of production on account of labor was considerably less.

Only a small part of the increase in employment under the new varieties is due to harvesting and threshing of the additional yield. The employment increase is mainly

Table 15—Labor input in rice cultivation for traditional and modern varieties, 1980-82 averages

Season/Variety	Land Preparation	Sowing and Transplanting	Weeding and Other Intercultural Operations	Harvesting and Threshing	All Operations
	(8-hour days/acre of cropped land)				
Aus					
Traditional	14	2	19	21	56
Modern	15	13	23	28	79
Aman					
Traditional, broadcast	11	1	15	25	52
Traditional, transplanted	13	13	7	20	53
Modern, transplanted	15	15	17	26	73
Boro					
Traditional	13	17	25	28	83
Modern	16	17	26	29	88
All seasons					
Traditional	13	7	13	22	55
Modern	15	16	22	28	81
Increase in modern over traditional	2	9	9	6	26

Sources: Compiled from International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* (Muscle Shoals, Ala.: IFDC, 1982); and International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1981/82* (Muscle Shoals, Ala.: IFDC, 1984).

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[47] Ahmed estimated from a survey of 459 farms in three villages during 1975/76 that, compared with traditional varieties, the labor input per unit of land in the cultivation of modern varieties was 28 percent higher during the aman season and 50 percent higher during the boro season. See Iftikhar Ahmed, "Technological Change and Labor Utilization in Rice Cultivation: Bangladesh," *The Bangladesh Development Studies* 6 (No. 3, 1977): 359-366.

due to the shift from direct seeding to transplanting of seedlings. For all new varieties, seedlings are grown on a separate seed bed and then transplanted to the main fields. On the other hand, inadequate rain and moisture in the soil during the premonsoon season does not permit transplanting of seedlings for the aus crop, so the seeds are broadcast on the main field, which does not require much labor. For traditional aman varieties the seedlings are transplanted, but mostly in a random manner, while new varieties are mostly transplanted in lines, thus requiring more labor than does random transplanting. The intensive intercultural operations such as weeding, irrigation, and fertilizer use also generate more demand for labor in the cultivation of MVs. The use of labor in land preparation is only marginally higher. Table 15 shows that MVs used 26 additional days of labor per acre, of which 35 percent was generated during sowing and transplanting, 35 percent during weeding and other intercultural operations, 23 percent during harvesting and threshing, and only 7 percent during land preparation.

Transplanting and harvesting are busy agricultural operations for which most farm households hire labor, although they may have surplus labor in the family during other times of the year. By raising labor requirements during these operations, MVs would also increase the demand for hired labor. The IFDC survey did not collect information on the use of hired labor. The estimates obtained from the BIDS/IFPRI survey are presented in Table 16. Nearly two-fifths of the total labor used in rice cultivation came from hired workers, and the proportion was almost the same under the traditional and modern varieties. The new technology thus appears to be neutral in the use of these two types of labor. During the boro and aus seasons, however, MVs use proportionately more hired labor than family labor. The agricultural operations for these two seasons take place from January to June, a traditionally slack period of agricultural activity. Diffusion of the new technology during these seasons would thus reduce the seasonality of underemployment, particularly for the landless who provide hired labor. It will be noted from Table 16 that the additional employment per unit of land generated by

Table 16—Use of hired labor under traditional and modern varieties of rice, 1982

Season/Variety	Hired Labor	Family Labor	Hired Labor as Share of Total Labor
	(8-hour days/acre)		(percent)
Aus			
Traditional	16	40	29
Modern	33	47	41
Aman			
Traditional, broadcast	20	32	38
Traditional, transplanted	22	32	41
Modern, transplanted	30	43	41
Boro			
Traditional	20	62	24
Modern	30	58	34
All seasons			
Traditional	20	36	36
Modern	30	50	38
		(percent)	
Difference in modern over traditional	50	39	6

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

MVs is proportionately more (50 percent) for hired labor than for family labor (39 percent). Thus, poor households who supply hired labor also benefit from technological progress. (See also Chapter 7.)

Animal and Mechanical Power

Bullocks and cows are widely used in Bangladesh to perform heavy agricultural operations such as plowing and leveling land, transporting harvests from the field to the yard of the homestead, and threshing the crop. The animals are used in pairs. The extent of animal power used in the cultivation of different varieties of rice, as estimated by the IFDC survey, is shown in Table 17. The figures are averages for 1979/80-1981/82. For land preparation, use of animal power is higher for transplanted varieties than for broadcast ones, but for harvesting and threshing no systematic pattern is observed. The average use under traditional crop varieties is about 128 hours per acre for a pair of animals. On the basis of an eight-hour working day, employment for a pair of animals comes to about 16 days per acre of land, which is less than one-third of the use of human labor (56 days).

The modern rice varieties generate more demand for animal power due to the practice of transplanting seedlings and the need to transport additional harvest. The extent of increase is found at 15 percent, about a third of the additional demand for human labor. The animal power used per ton of output is 105 pair-hours for MVs, compared with 196 hours for traditional varieties.

In Bangladesh, the market for animal labor is very thin, partly because of the highly seasonal pattern in demand for animal services. The BIDS/IFPRI survey collected information on cultivation expenses for hired animals during the 1982 crop seasons. Only

Table 17—Use of animal and mechanical power for traditional and modern varieties, 1979/80-1981/82 averages

	Animal Power			Mechanical Power			
Season/Variety	Land Preparation	Harvesting and Threshing	Total	Land Preparation	Irrigation	Threshing	Total
	(hours/pair/acre)			(hours/acre)			
Aus							
Traditional	114	24	138	0	0	6	6
Modern	123	26	149	0	7	9	16
Aman							
Traditional, broadcast	89	36	125	0	0	8	8
Traditional, transplanted	106	14	120	0	0	9	9
Modern, transplanted	115	24	139	0	1	9	10
Boro							
Traditional	102	36	138	0	13	4	17
Modern	125	29	154	0	30	9	39
All seasons							
Traditional	105	22	127	0	1	7	8
Modern	121	26	147	0	15	9	24
				(percent)			
Difference in modern over traditional	15	18	15	. . .	large	29	200

Sources: Compiled from International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* (Muscle Shoals, Ala.: IFDC, 1982); and International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1981/82* (Muscle Shoals, Ala.: IFDC, 1984).

one-fourth of the farmers reported use of hired animals. The average use was equivalent to about 11 pair-days for those hiring animals, and only 3 days for all farms. The practice of animal hiring was more prevalent among very small farmers, presumably because they cannot afford to invest in a pair of animals and bear the maintenance cost. Some large landowners, whose main occupation was nonagriculture, also hired animal power. Owing to the thinness of the market, most of the households that are engaged full time in farming have to keep at least a pair of draft animals, which remains substantially underutilized. Thus the animals are fixed costs, and the cost per unit of output on this account can be reduced by increasing the rate of utilization. The diffusion of modern technology allows more intensive use of animals, since an additional crop is grown on the same piece of land each year.

In many parts of South Asia, diffusion of the new technology followed substitution of machines for animal and human labor. This change is often mentioned as an important factor behind the negative distribution effect of the new technology, although the effect of mechanization on labor use remains controversial.[48] In Bangladesh, mechanization of agricultural operations, except for irrigation, is rarely visible. In some parts of the country a few farmers use small mechanical threshers (mostly in the Comilla, Noakhali, and Chittagong belt), and power tillers (mainly in the Dhaka region for potato cultivation). The 1977 agricultural census noted that among 6.3 million farm holdings, only 35,000 used tractors and 12,000 used power tillers at some time.[49] Only 0.66 percent of farmers reported mechanical cultivation, and the area cultivated was only 0.38 percent.

Information on the use of mechanical power in alternative rice technologies, as estimated by the IFDC survey, is reported in Table 17. Mechanical power is used only for irrigation and threshing. For traditional varieties, mechanical power was used for only eight hours per acre—about 3 percent of the use of animal power. Under MVs, the use is about three times more, but most of the increase is due to power used for irrigation. For threshing, the use is only about one-fifth higher. For land preparation, mechanization has yet to be introduced, even for the cultivation of MVs.

Chemical Fertilizer and Manure

The use of chemical fertilizers is now widespread. The BIDS/IFPRI survey found that nearly 87 percent of farmers used fertilizers, and in irrigated villages almost all farmers used them. Only in 4 out of 16 villages studied was the diffusion limited to less than two-thirds of the farmers. Three of the villages are located in the coastal district of Khulna, which has saline soil, and most of the land is single-cropped with local transplanted aman. The other village is located on the Brahmaputra active flood plain, where most of the land is sown with deep-water broadcast aman.

Many of the fertilizer-using farmers, however, did not apply fertilizer on all plots. The application depends on the type of crop, and whether the plot has previously been treated with fertilizer. The farmers argue that once they apply fertilizer on a plot (for example, to grow the highly fertilizer-responsive MVs), they will have to continue using fertilizer on the same plot even for growing a local variety with low fertilizer response—otherwise the yield will be less than normal. The IFDC survey found that during 1981/82 nearly 45 percent of the land was not treated with fertilizer.

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[48] For a recent survey of the literature on the labor-displacing effects of agricultural mechanization, see Michael Lipton, *Modern Varieties, International Agricultural Research, and the Poor,* CGIAR Study Paper 2 (Washington, D.C.: World Bank, 1985), pp. 64-70.

[49] Bangladesh, Bureau of Statistics, *The Statistical Yearbook of Bangladesh, 1984-85* (Dhaka: Ministry of Planning, 1985), p. 332.

The findings of the two surveys on the extent of fertilizer use under alternative rice technologies are presented in Table 18. The figures indicate a clear dualism in fertilizer application. Less than one-fifth of the land under deep-water aman and traditional boro is treated with fertilizer. These crops are grown on deep-flooded land where local varieties are less fertilizer-responsive and fertilizer use is less effective. Even on flood-free land, only about 50 percent of the plots are treated with fertilizer if they are sown with local varieties, but more than 90 percent are treated if they are sown with MVs. Fertilizer use on aus and boro season MVs is about six times higher than on the substitute traditional variety, and on aman season MVs the use is about three times higher. On transplanted MVs, use of fertilizers has reached a high level—over 113 kilograms of materials per acre of land. The higher yield of MVs is thus achieved by substantially higher use of chemical fertilizer per unit of land.

To increase soil fertility, Bangladesh farmers also use manures, so a pertinent question is whether intensive fertilizer application on MVs has led to the substitution of chemical fertilizers for manures. The BIDS/IFPRI survey found that nearly two-thirds of the farmers applied farmyard manure, while the IFDC survey found that nearly one-third of the plots were treated with manure. The application of manure was more common in traditional varieties. The findings of the two surveys, however, do not agree on the magnitude of application of manure (Table 18). The IFDC survey showed that use of manure was about [illegible]0 percent lower for MVs, while the BIDS/IFPRI survey indicated that farmers used almost twice as much on MVs as on traditional varieties.

Table 18—Use of chemical fertilizers and manure for traditional and modern varieties, 1980-82 averages

Season/Variety	Share of Plots Treated (IFDC Survey)		Use per Acre (IFDC Survey)		Use per Acre (BIDS/IFPRI Survey)	
	Fertilizer	Manure	Fertilizer[a]	Manure	Fertilizer[a]	Manure
	(percent)		(kilograms)	(metric tons)	(kilograms)	(metric tons)
Aus						
Traditional, broadcast	45	61	19	1.81	19	1.60
Modern, broadcast[b]	74	66	41	1.93	[c]	[c]
Modern, transplanted	98	29	114	0.61	96	0.89
Aman						
Traditional, broadcast	18	15	7	0.15	5	0.59
Traditional, transplanted	54	24	22	0.25	18	0.10
Modern, transplanted	84	9	68	0.17	84	0.23
Boro						
Traditional, transplanted	12	3	9	0.06	1	0.00
Modern, transplanted	96	34	117	0.62	130	2.22
All seasons						
Traditional	43	33	18	0.71	15	0.65
Modern	91	25	94	0.49	106	1.42

Sources: Compiled from International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* (Muscle Shoals, Ala.: IFDC, 1982); International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1981/82* (Muscle Shoals, Ala.: IFDC, 1984); and data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] The figures for fertilizer are in weights of different kinds of materials (urea, phosphate, and potash). The nutrient content may be obtained by multiplying the figures by 0.46.

[b] According to the International Fertilizer Development Center survey, about one-fourth of the MV aus area was broadcast-seeded. Information on this is not available for the country as a whole.

[c] In the Bangladesh Institute of Development Studies/International Food Policy Research Institute survey area, modern broadcast aus variety was not grown.

Irrigation and Pesticides

According to the IFDC survey, irrigation was rarely practiced in the cultivation of local aus and aman, but about 65 percent of the plots under traditional boro and 89 percent of the plots under modern boro were irrigated (see Table 19). During the aman season, MVs are grown basically under rain-fed conditions. The intensity of irrigation, as measured by the average number of times of irrigation, is also highest in the cultivation of MVs of boro.

The market for irrigation is imperfect, and the cost of irrigation per unit of land varies widely, depending on the source of irrigation and on the type of ownership of irrigation equipment. Irrigation was provided free of cost to farmers in 2 of the 16 villages in the BIDS/IFPRI survey, as they happened to be under the Ganges-Kobtak project area of the Bangladesh Water Development Board. Two of the villages used low-lift pumps, rented to farmers' cooperatives by the Bangladesh Agricultural Development Corporation. In these villages the water charge paid by farmers varied from Tk 230 to Tk 320 per acre. In three villages where irrigation has been practiced since the late 1960s under the auspices of Comilla-type cooperatives, a combination of low-lift pumps, shallow tubewells, and deep tubewells has been used, and the water charge came to about Tk 650 per acre. In another three villages, irrigation was recently introduced by private shallow tubewell owners, who sold water to owners of adjoining plots at a charge varying from Tk 1,400 to Tk 1,800 per acre. Thus the water charge observed at the farm level in no way measures the irrigation input. The average water charge in the cultivation of boro MVs comes to about Tk 690 per acre for the sample as a whole—about one-eighth of the gross value of output.

Pesticides are rarely used on local varieties, but some use in MVs was noted (Table 19). The increase in cost on this account is only marginal. The highest level of use is on MVs grown during the aus and boro seasons. For these crops the cost on account of pesticides was reported at Tk 90 per acre—only 1.5 percent of the gross value of output.

Table 19—Use of irrigation and pesticides under traditional and modern varieties of rice, 1980-82 averages

Season/Variety	Share of Plots Irrigated	Mean Number of Times Irrigated	Share of Plots Treated with Pesticides	Average Use of Pesticides
	(percent)	(average for plots)	(percent)	(kilograms/ acre)
Aus				
Traditional, broadcast	0	0.0	3	. . .
Modern, broadcast	3	. . .	9	0.12
Modern, transplanted	61	5.4	19	0.25
Aman				
Traditional, broadcast	0	0.0	0	0.00
Traditional, transplanted	5	0.1	. . .	. . .
Modern, transplanted	14	0.8	17	0.12
Boro				
Traditional	65	4.4	3	. . .
Modern	89	7.4	50	0.79

Sources: Compiled from International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* (Muscle Shoals, Ala.: IFDC, 1982); and International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1981/82* (Muscle Shoals, Ala.: IFDC, 1984).

Seeds

The amount of seed used per unit of land depends on whether the seed is broadcast or a separate seedbed is prepared to grow seedlings that are then transplanted to the main field. According to the Bangladesh Bureau of Statistics, the normal seed requirement for broadcast varieties is 32-37 kilograms per acre, while for transplanted varieties it is about 8-10 kilograms.[50] The value of seedlings is, however, higher than the cost of seeds used, because of the additional cost of land and labor used in seedbed preparation. For traditional varieties, seeds are generally kept from the harvest, but for MVs a significant proportion of the seed may be purchased from markets or government centers (particularly if the seed is new in the area), hence the cost may be higher.

The cost per unit of land was lower for transplanted varieties than for broadcast ones (see Table 20).

Among transplanted crops, the seed cost per unit of land is found to be higher for MVs by about 16 percent for the aman season and nearly 55 percent for the boro season. For all seasons together, the seed cost per acre is almost the same, but because of higher yield, the cost per unit of output for MVs is only about half of that for traditional varieties (Table 20).

Unit Costs and Profitability of Cultivation

This section estimates the effect of the changes in input-output relationships described above on the costs and profitability of rice cultivation. First, estimates are derived by applying national-level prices on the average input-coefficients for 1980-82 (IFDC survey), except for seed, for which the information is only available for 1982. In order to dissociate the effect of climatic factors, the average crop yield for the last three years (1982-85), as reported in official statistics, is used for estimating the gross returns. Then, BIDS/IFPRI survey data are used to estimate profits for different groups of farms at the farm-specific prices of inputs and output.

Table 20—Cost of seeds for traditional and modern varieties of rice, 1982

Season/Variety	Cost per Acre	Cost as Share of Output
	(Tk)	(percent)
Aus		
Traditional	183	9.8
Modern	130	2.6
Aman		
Traditional, broadcast	175	6.5
Traditional, transplanted	135	4.9
Modern, transplanted	158	3.5
Boro		
Traditional	107	2.7
Modern	165	2.8
All seasons		
Traditional	156	6.3
Modern	156	3.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

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[50] Ibid.

National information on farm prices of inputs is not available, except for wage rates. The IFDC survey estimated that for urea, which accounts for over 70 percent of chemical fertilizers consumed in the country, the farm prices were higher than the officially fixed prices in the range of 2.8-10.7 percent for the eight crop seasons for which information was collected. In calculating fertilizer costs, it is assumed that farmers pay about 10 percent more than the official prices set by the government, the variable for which time series information is available. As mentioned earlier, the unit cost of irrigation varies across locations, depending on the source of water. To standardize the cost, the weighted average water charges paid by irrigators to private owners of shallow tubewells (as found in a recent survey by Quasem)[51] are used as the standard to estimate the irrigation cost for other crops by applying the IFDC survey information on the mean number of times a crop is irrigated. For other time periods, the irrigation cost has been adjusted by the price index of diesel. The farm price of manure is available from the IFDC survey for 1980. Similarly, the cost of seed is available only for 1982 (Table 20). For other time periods, the manure and seed costs are derived by adjusting them by the price index of rice. It is reported in a 1980 survey of six villages in Comilla and Noakhali that the hiring charge for a pair of animals, along with the worker who operates them, is about 2.5 times higher than the wage rate paid to hired workers.[52] On this basis, the cost of a pair of animals is assumed at 1.5 times the wage rate, since the hired worker is included in the input of human labor. The family labor input is imputed by the wage rate of the hired labor.

The cost of mechanical power could not be included due to nonavailability of information on rental charges for machines. In any case, nearly two-thirds of the mechanical power input is on account of irrigation, the costs of which are included in irrigation charges. The unaccounted input is only about eight hours per acre (in threshing), the cost of which would be very low as a proportion of the value of output.

Land is an important fixed asset, but the opportunity cost of the investment in land has not been included in the cost of production. The justification is that land, unlike other fixed assets, does not depreciate in value, particularly in countries where land is scarce. According to the Bangladesh Bureau of Statistics, during 1973-84 the price index of single-cropped, unirrigated land (the type of land not affected by productivity-raising investment) increased at an annual rate of about 17.6 percent, compared with the 11 percent rate of inflation during this period and the 14 percent rate of interest currently paid by commercial banks on fixed deposits. Thus a person investing in land can get a higher return than the interest on money deposited in banks, even if the land is kept fallow. In this sense, use of the land for cultivation does not involve any real cost to its owners. For tenants, however, the rent paid to the landowner is a real cost and has to be included in estimating their profits.

Another cost element that has not been included in the estimates is the rate of interest paid on working capital borrowed from outside. In Bangladesh, farmers borrow for agricultural purposes from various institutional sources, which generally charge 16 percent interest annually. Borrowings from informal sources for extremely short periods are widespread. These informal loans bear high rates of interest (10 percent a month is common) and so may not be used for financing production expenses. Also, information on credit is available at the household level and is difficult to apportion to various crops. The BIDS/IFPRI survey found that the sample farmers borrowed an average of Tk 150 per acre of cropped land from institutional sources during 1982. This amount constituted only one-fourth of total borrowing. The cost has not been included because of the problem of apportioning it to various crops.

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[51] Md. Abul Quasem, *Impact of the New System of Distribution of Fertilizer and Irrigation Machines in Bangladesh—Survey Findings,* Research Report 62 (Dhaka: Bangladesh Institute of Development Studies, 1987), p. 30.

[52] Bangladesh Unnayan Parishad, *A Socio-Economic Evaluation of the Chandpur II Irrigation Project,* a report prepared for the World Bank (Dhaka: Bangladesh Unnayan Parishad, 1982), app. A, pp. 6-25.

The choice of an appropriate price for output is a problem. Here the growers' price of paddy as reported by the Bangladesh Bureau of Statistics is used. The government also declares, in advance of the harvest, a procurement price for paddy at which the farmers can sell their produce at government-operated purchasing centers. While it is estimated that nearly 40 percent of the rice is marketed, the average procurement of the government in 1980-85 was only about 2 percent of domestic production. Use of the growers' price thus appears more appropriate. Another problem is the quality differences for different varieties of rice. The grain of the rice MVs produced during the aus and boro seasons is coarse and fetches the lowest price in the market. Among traditional varieties, aus and boro are coarse, while aman grains are generally of superior quality and fetch the highest prices. Information provided by the Department of Agricultural Marketing shows that the average price of fine-quality aman rice during 1980-84 was about 22 percent higher than the price of MV rice.[53] For the present calculation, the reported average growers' prices for traditional varieties of aus and boro and MVs of aman have been applied, and prices have been assumed to be 10 percent higher for traditional aman and 10 percent lower for MVs of aus and boro.

Estimates of costs and returns have been made at prices for 1984/85, the most recent year for which price information was available. However, the relative input-output prices underwent considerable change during 1975-85, partly because of the government policy of gradual withdrawal of subsidies from modern inputs such as fertilizers and irrigation, which are used more in the cultivation of MVs. Some of the profitability gains of the new technology may have been eroded by such price changes. In order to see the effect of price changes on profitability, costs and profits have also been estimated at 1975/76 prices.

The estimates of costs and profits at 1984/85 prices are presented in Table 21. The "cash cost" includes the cost of seed, fertilizer, manure, irrigation, pesticides, and hired labor, while the "total cost" also includes the imputed value of family and animal labor. Small farmers and tenants who have surplus family labor and low opportunity cost of employing it elsewhere may give more weight to cash costs in making production decisions than to total cost, which is a more relevant variable for the large farmers who have high opportunity cost of family labor. The cash cost per unit of land also shows the working capital requirement, and the small farmer may be in a more disadvantaged position to supply it than the large farmer, who would have a higher amount of surplus (production over family consumption) and better access to financial institutions. In the cultivation of traditional varieties, the cash cost of production per unit of land is almost the same in the aus and aman seasons, but about three-fourths higher in the boro season because of the requirement for irrigation. Per unit of output, however, the cost is lowest for the aman season crops. In transplanted aman, the cost is about one-fourth lower than for aus (highland) or boro (lowland) varieties.

In the cultivation of MVs, the cash cost per unit of land is about 1.7 times higher than for the traditional varieties—1.9 times for the aus season, 1.1 times for the boro season, and nearly three-fourths for the aman season. The MVs have higher yields, but

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[53] Bangladesh, "Wholesale Prices of Agricultural and Animal Products in Bangladesh, 1972-85," Department of Agricultural Marketing, Dhaka, 1986 (mimeographed).

Table 21—Costs of production and profits under traditional and modern varieties, at 1984/85 national-level prices

Season/Variety	Cash Costs		Total Costs		Estimated Profit	
	Per Acre	Per Metric Ton	Per Acre	Per Metric Ton	Per Acre	As Share of Costs
			(Tk)			(percent)
Aus						
Traditional	736	1,466	2,524	5,027	−35	−1
Modern	2,121	1,612	4,149	3,153	1,723	42
Aman						
Traditional, broadcast	737	1,205	2,261	3,699	1,071	47
Traditional, transplanted	811	1,089	2,299	3,086	1,764	77
Modern, transplanted	1,406	1,198	3,242	2,761	2,578	80
Boro						
Traditional	1,354	1,454	3,666	3,937	950	26
Modern	2,808	1,696	5,136	3,102	2,253	44
All seasons						
Traditional	799	1,226	2,425	3,720	1,038	43
Modern	2,122	1,510	4,200	2,990	2,296	55
			(percent)			
Difference in modern over traditional	166	23	73	−20	121	12

Source: Estimated from International Fertilizer Development Center survey data.

per unit of output the cash cost is also higher for their cultivation. For all three seasons, the weighted average difference is about 23 percent. The absolute cash cost on account of purchased inputs is Tk 1,513 per ton of paddy for MVs and Tk 1,226 for traditional varieties.

A different conclusion is reached if total cost of production is considered. The cost per unit of land is higher by about three-fourths for the cultivation of MVs than for traditional varieties, but the cost per unit of output is lower by about one-fifth. The absolute cost per ton of paddy is Tk 3,720 (US$124) for traditional varieties and Tk 3,000 (US$100) for MVs. Compared with traditional aus (the main substitute crop), which has the highest unit cost of production (US$168 per ton), the cost of cultivation of MVs is lower by about 40 percent.

Since land is scarce, the farmer is interested in maximizing the net return per unit of land. At the assumed average prices the profit (gross return minus total cost) is negative for cultivation of the traditional aus variety[54] and is substantially lower for all other traditional varieties compared with MVs. For all seasons, the difference in net return per unit of land is Tk 1,250 per acre—about 1.2 times higher for cultivation of MVs than for traditional varieties. Subsistence farmers may be interested in maximizing the net return to the family (gross returns minus cost of purchased inputs). The new technology gives a better return in this respect also. The return to family inputs is estimated at Tk 4,370 per acre for MVs, compared with Tk 2,670 for traditional varieties—an increase of about 64 percent. The family income per day of labor is estimated at Tk 87 for MVs, compared with Tk 75 for local varieties. The wage rate of agricultural labor prevailing in 1984/85 for the country as a whole was Tk 24.

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[54] The traditional aus is a very low yield crop, and in areas in which it is a major crop, the wage rate is also found to be very low. For the BIDS/IFPRI sample, the wage rate paid for cultivation of local aus is estimated at Tk 12.92 per day, compared with Tk 23.88 in the cultivation of modern-variety boro. If the cost of labor is evaluated at the crop-specific wage rate, the net profit in the cultivation of local aus would also be positive.

Households that consider farming as an investment alternative base their decisions on the rate of return on capital. The estimates of total cost show that the new technology gives scope for investing more capital on a fixed amount of land. The rate of profit, measured as a percentage of total cost, is also found to be higher for MVs, particularly during the aus and boro seasons. For all three seasons, the rate of profit is estimated at 55 percent for the new varieties compared with 43 percent for the traditional ones.

Whether the farmers would consider the rate of profit adequate to maintain a reasonable standard of living is a separate issue. Comparison of the rate of profit in farming with that in nonagricultural activities is not justified, because accumulation of capital in farming is constrained by the amount of land owned, while in nonagriculture profits can be reinvested for further accumulation. Only about 5 percent of households in Bangladesh operate farms larger than 7.5 acres. If a 7.5-acre farm grew one traditional and one modern variety during a year, it would have a profit of about Tk 24,700, which for a six-member household gives a per capita income of Tk 4,110. For 1984/85 the per capita income for the nation was estimated at Tk 3,990, and the poverty-level income at Tk 3,096.[55] Thus, even at this high rate of profit, farming alone does not guarantee an acceptable standard of living for a large-farm family.

The effect of the changes in agricultural prices during 1975-85 on cost and profitability in rice cultivation is shown in Table 22. Owing to the gradual withdrawal of

Table 22—Effect of price changes on costs of production and profits, 1975/76-1984/85

Season/Variety	Costs of Production 1975/76	Costs of Production 1984/85[a]	Costs of Production Change	Profits 1975/76	Profits 1984/85[a]	Profits Change
	(Tk/acre)		(percent)	(Tk/acre)		(percent)
Aus						
Traditional	928	1,104	19	41	−15	large negative
Modern	1,402	1,814	29	883	753	−15
Aman						
Traditional, broadcast	831	989	19	465	468	1
Traditional, transplanted	838	1,005	20	743	771	−4
Modern, transplanted	1,144	1,418	24	1,121	1,128	1
Boro						
Traditional	1,256	1,603	28	540	415	−23
Modern	1,669	2,246	35	1,207	985	−18
All seasons[b]						
Traditional	890	1,060	19	437	454	4
Modern	1,423	1,836	29	1,097	1,004	−8
Total	965	1,[illegible]5	32	530	606	14

Source: Estimates are based on crop-level input-output data obtained from the International Fertilizer Development Center survey and on prices of inputs and output in Bangladesh, Bureau of Statistics, *The Statistical Yearbook of Bangladesh*, various issues (Dhaka: Ministry of Planning, various years).

[a] Estimated at 1984/85 prices of inputs and output and then converted at 1975/76 constant prices by using the consumer price index for 1975/76 and 1984/85.

[b] Weighted averages, using the share of crop variety of the total cropped area under rice in Bangladesh for the referenced year.

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[55] The Bangladesh Bureau of Statistics has recently made estimates of the poverty line income for 1981/82 from the returns of the national household expenditure survey. This figure is based on this estimate, adjusted for changes in the cost-of-living index. For details see Chapter 8 of this study.

subsidies, input prices have increased faster than output prices. The cost of cultivation in real terms increased by about one-third during that period, and the rate of increase was faster for MVs, since they are more fertilizer- and water-intensive. The rate of profit over the investment in working capital declined from about 55 percent in 1975/76 to 48 percent by 1984/85; the rate of decline has been faster for MVs—from about 77 percent to 55 percent during the same period. The profit per unit of the scarce factor, land, has also declined, particularly for aus and boro season crops. But the absolute profit in cultivating MVs remains much higher than that for traditional varieties. In spite of declining profits in individual crop varieties, farmers have increased the profits per unit of land for all crops taken together, through reallocation of land from low- to high-profit crops. The share of MVs in the total sown area under rice doubled from about 14 percent in 1975/76 to 28 percent by 1984/85. The productivity growth as a result of this reallocation of land has ensured farmers about 14 percent higher profits in spite of the adverse movement in relative input-output prices.

The government controls the supply of fertilizer and irrigation, and the operation involves a considerable amount of subsidy. Since these inputs are consumed more in the cultivation of MVs than traditional varieties, a pertinent question is what would happen to the difference in costs and profits if the subsidies were fully withdrawn. As mentioned earlier, through a number of consecutive price increases the fertilizer subsidies had been withdrawn by 1985. The fertilizer price used in the calculation (US$167 per ton) is close to the world price. The cost of irrigation would, however, increase if subsidies were withdrawn. The Master Plan organization estimated that for 1984 the annualized capital cost plus the operation and maintenance for irrigation would come to Tk 1,720 per acre for deep tubewells and Tk 1,530 for large-scale irrigation projects (at economic prices).[56] In the cost calculation a water rate of Tk 1,250 per acre was assumed. Thus, if the subsidies are withdrawn, the irrigation charge to farmers may increase by about 37 percent.[57] At this price the total cost of production would be Tk 3,168 per ton of paddy for MVs, compared with Tk 3,738 for traditional varieties—still about 15 percent lower. The net profit would be Tk 2,050 per acre for MVs, compared with Tk 1,025 for traditional varieties.

The estimates of costs and profits at farm-specific prices, input use, and yield rates obtained from the BIDS/IFPRI survey are shown in Table 23. To estimate total costs, family labor was imputed at the wage rate paid by the household to hired labor. For households that did not hire labor, the average wage rate for the village was used to impute cost. Costs on account of animal labor supplied by the family could not be included, as the survey did not collect information on this variable. Seeds, both household-supplied and purchased, were included in cash costs. The estimates show substantially higher costs of production for cultivation of MVs than for local varieties, but the superiority of MVs is clearly demonstrated in profits and family income per unit of land. Cultivation of MVs yielded Tk 1,570 additional profits per acre of land and Tk 1,835 additional return to family labor and animals. The net income per day of family labor is estimated at Tk 53 for local varieties and Tk 74 for MVs, while hired labor was paid an average wage of Tk 19.5.

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[56] Cited in Hossain, "Fertilizer Consumption," p. 224.

[57] The actual subsidy on irrigation may in fact be higher than this proportion. A large part of the irrigation subsidy is consumed by owners of irrigation machines, who charge substantially higher prices to water users than the capital and operation costs. For 1982/83 the markup (water charge paid by irrigators over the cost) is estimated at 62 percent for deep tubewells, 34 percent for power pumps, and 10 percent for shallow tubewells. See Osmani and Quasem, "Pricing and Subsidy Policies," p. 166.

Table 23—Costs and profitability at farm-specific prices, production and input use, 1982

Season/Variety	Gross Value of Output	Cash Costs of Production	Total Costs of Production	Returns to Family Labor	Profits
			(Tk/acre)		
Aus					
Traditional	1,618	528	992	1,090	626
Modern	5,395	1,381	1,931	4,014	3,464
Aman					
Traditional, broadcast	2,596	569	1,023	2,027	1,573
Traditional, transplanted	2,737	742	1,118	1,995	1,619
Modern, transplanted	4,854	1,193	1,777	3,661	3,077
Boro					
Traditional	3,800	536	960	3,264	2,840
Modern	5,767	2,103	2,945	3,664	2,822
All seasons					
Traditional	2,511	626	1,050	1,885	1,461
Modern	5,330	1,610	2,299	3,720	3,031
All varieties	3,292	899	1,396	2,393	1,896

Source: Estimated from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey data.

Table 24 shows the estimates of profits for different farm sizes and tenurial groups. For MVs, profits are higher on larger farms, but for traditional varieties no systematic pattern is found. The tenants pay 50 percent of the gross produce as rent for the sharecropped land. After deduction of the rent the profit is very small on the sharecropped land, but is higher for MVs than for local varieties. The net return to tenants' family labor and draft animals was Tk 750 per acre for local varieties and Tk 1,140 for MVs, or about 52 percent higher. The net return per day of tenants' labor is estimated at Tk 21 for local varieties and Tk 23 for MVs—only marginally higher than the average rate of Tk 19.5 for the entire sample. Thus the rented land benefits tenant farmers mainly through reducing underutilization of family labor and animals.

Table 24—Profits and family income at farm-specific prices for different farm sizes and tenurial groups, 1982

Group of Farmers	Profits			Return to Family Labor and Animals		
	Traditional Varieties	Modern Varieties	Difference	Traditional Varieties	Modern Varieties	Difference
	(Tk/acre)		(percent)	(Tk/acre)		(percent)
Landownership group						
Small (less than 2.5 acres)	1,355	2,619	93	1,688	3,747	100
Medium (2.5 to 5.0 acres)	1,539	2,669	73	1,967	3,349	70
Large (5.0 or more acres)	1,448	3,685	155	1,787	4,152	132
Tenurial group						
Owner-cultivator	1,322	3,062	132	1,797	3,682	105
Owner-cum-tenants	1,154	2,049	78	1,578	2,829	79
Owned land	1,069	2,974	85	2,034	3,754	85
Rented land	323	360	12	748	1,140	52

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Comparison of relative gains from adoption of MVs across different groups shows that owner-farmers gain more than tenants, and large farmers gain more than small and medium ones. But the gains of small farmers are also higher than those of medium ones. Thus the gains are not systematically positively related to the size of household landownership.

Conclusions

The rice MVs have opened up an opportunity to increase production substantially from a given amount of land. The yield of MVs on a farmer's field is twice that of the traditional varieties. The fluctuations in yield caused by natural factors are also lower for MVs, indicating that the new technology has reduced the risk of cultivation. Farmers use about 45 percent more labor per unit of land for the cultivation of MVs than for traditional varieties. But per unit of output, use of labor is about 35 percent lower, and use of draft power is about 45 percent lower for MVs. The new crops, however, use substantially more fertilizer, irrigation, and pesticides per unit of output. The cash costs of production per unit of land are about 1.7 times higher, and per ton of output are about one-fifth higher for MVs. The total cost of production per ton of paddy is estimated (at 1984/85 prices) at US$100 for MVs, compared with US$124 for traditional varieties. The profit per acre of land is estimated at Tk 2,300 for MVs, which is about 2.2 times that for traditional varieties (Tk 1,040). The rate of profit over the cost of production is 55 percent for MVs, compared with 43 percent for traditional varieties. The gradual withdrawal of subsidies from fertilizer and irrigation during 1975-85 has reduced the profitability gap, but farmers have increased their profits from cultivation of rice through reallocation of land from traditional to modern varieties, since the absolute profit for MVs is still higher. Even if subsidies were fully withdrawn, the profit per unit of land would still be about twice as much for cultivation of new varieties as for traditional ones, and the unit cost of output would be about 15 percent lower.

5

PRODUCTIVITY AND EFFICIENCY OF RESOURCE USE

The effects of the new technology on productivity of land and labor and on efficiency in their utilization are assessed in this chapter. Land is the most scarce input in Bangladesh. It could be argued that the development of irrigation, which is the most critical input in the modern technology package, could raise the effective supply of land by creating conditions for growth of an extra crop on fallow land during the dry winter season.[58] In order to see whether and to what extent this has happened in Bangladesh, the first section compares the pattern and the intensity of land use in the technologically developed and underdeveloped areas as well as on the irrigated and unirrigated land. This is followed by an analysis of the production function for estimating the factor shares and the marginal productivity of land and labor for traditional and modern technology. The final section applies a profit function model to study the relative economic efficiency of adopters of the new technology and farmers still growing only traditional crops.[59] The analyses in this and the following chapters are based on disaggregated farm and plot data collected by the BIDS/IFPRI survey.[60]

Intensity of Land Use and Cropping Patterns

The effect of technological change on the pattern and intensity of land use can be seen in Tables 25 and 26. The tables are based on information collected at the plot level on the use of the land during the three crop seasons in 1981 in the 16 villages covered by the BIDS/IFPRI survey. The survey enumerated 5,255 plots belonging to 639 sample households (8.2 plots per household). About 68 percent of the plots were owner operated; 13 percent were rented out to others, mostly under sharecropping arrangements; 6 percent were under orchards or bamboo bushes; 2 percent were under ponds; and the remaining 11 percent were under homesteads. Some of the landowners did not know about the use of the plots operated by tenants, so complete information could not be obtained for this type of land. It was also found that the practice of renting out land for only one season was prevalent; the plot rented out for cultivation during the boro season was taken back by some landowners for self-cultivation during the aman season. To avoid problems caused by these complications, the information presented here is based on the data obtained for the owner-operated plots only. The following main points can be noted from the information.

Irrigation has a significant effect on increasing the effective supply of land during the boro season. Only two-fifths of the unirrigated land is cropped during the boro

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[58] Shigeru Ishikawa, *Economic Development in Asian Perspective* (Tokyo: Kinokuniya, 1967). For Bangladesh this hypothesis has been tested in James K. Boyce, "Water Control and Agricultural Performance in Bangladesh," *The Bangladesh Development Studies* 14 (No. 4, 1986): 1-35.

[59] Lawrence J. Lau and Pan A. Yotopoulos, "Profit, Supply and Factor Demand Functions," *American Journal of Agricultural Economics* 54 (No. 1, 1972): 11-18; and Lau and Yotopoulos, "A Test for Relative Efficiency and an Application to Indian Agriculture," *American Economic Review* 61 (No. 1, 1971): 94-109.

[60] BIDS/IFPRI, *Development Impact.*

Table 25—Pattern and intensity of use of irrigated and unirrigated land, 1981

	Irrigated Land		Unirrigated Land	
Season/Crop	Sown Area	Share of Cultivated Land	Sown Area	Share of Cultivated Land
	(acres)	(percent)	(acres)	(percent)
Aus	70.84	21.0	198.20	30.4
Local aus	12.82	3.8	148.65	22.8
Modern-variety aus	54.41	16.1	4.25	0.6
Jute	3.60	1.1	45.30	7.0
Aman	227.80	67.6	412.10	63.2
Local broadcast aman	18.23	67.6	119.82	63.2
Local transplanted aman	83.76	24.9	237.27	36.4
Modern-variety aman	125.45	37.2	15.75	2.4
Sugarcane	0.35	0.1	39.25	6.0
Boro	257.50	75.4	251.15	38.6
Local boro	14.75	4.4	44.40	6.8
Modern-variety boro	196.65	58.3	13.55	2.1
Wheat	9.40	2.8	21.17	3.3
Pulses	10.03	3.0	117.00	18.0
Oilseeds	19.80	5.9	21.35	3.3
Vegetables	5.35	1.6	15.20	2.3
Spices	1.50	0.5	14.38	2.2
Other	. . .	. . .	4.10	0.6
Total cropped land	556.15	165.0	861.45	132.2
Total cultivated land	337.10	100.0	651.75	100.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.
Note: Parts may not add to totals because of rounding.

season, but with irrigation the intensity of use increases to about three-fourths (Table 25). Part of the increase is at the expense of the overlapping aus season crops, which are grown on 30 percent of the unirrigated land, but on only 21 percent of the irrigated land. MV boro, for example, competes for land with local aus and jute. It is harvested at the beginning of May, when it is too late to broadcast aus and jute seeds on the same land. About 31 percent of the land remains fallow over these two seasons when the land is unirrigated, but the proportion is reduced to only 14 percent with access to irrigation facilities. Irrigation, however, does not change the pattern of land utilization during the aman season, when crops are grown basically under rain-fed conditions. Two-thirds of the cultivated land is cropped during the aman season; one-third remains fallow, presumably owing to excessive flooding. Provision of irrigation facilities does not appreciably change the proportion of aman season fallow land.

The adoption of MVs is facilitated mostly by irrigation. Only 6 percent of the unirrigated land was used to grow MVs during the three seasons. For irrigated land the proportion was about 112 percent, which also indicates that some of the land was used to grow two MV rice crops during the same year. Of the 86 percent of irrigated land cropped during the aus and boro seasons, 75 percent was used for growing MV rice. Only during the aman season was a large proportion of the irrigated land used to grow local paddy.

Irrigation has an adverse effect on diversification of crops. Except for rice and oilseeds, all crops are grown less often on irrigated land than on unirrigated land. Following the development of irrigation facilities, rice varieties replace not only the low-yielding pulses but also the major cash crops, jute and sugarcane. These three

Table 26—Pattern and intensity of land use in technologically developed and underdeveloped villages, 1981

Season/Crop	Developed Villages		Underdeveloped Villages		All Villages	
	Cropped Land	Share of Cultivated Land	Cropped Land	Share of Cultivated Land	Cropped Land	Share of Total Cultivated Land
	(acres)	(percent)	(acres)	(percent)	(acres)	(percent)
Aus	100.78	21.4	168.23	32.5	269.01	27.2
Local aus	29.20	6.2	132.30	25.6	161.50	16.3
Modern-variety aus	51.67	11.0	6.96	1.3	58.63	5.9
Jute	19.91	4.2	28.97	5.6	48.88	5.0
Aman	312.80	66.4	327.05	63.1	639.85	64.7
Local broadcast aman	58.59	12.4	79.46	15.3	138.05	14.0
Local transplanted aman	110.34	23.4	210.72	40.7	321.06	32.5
Modern-variety aman	134.96	28.7	6.22	1.2	141.18	14.3
Sugarcane	8.92	1.9	30.65	5.9	39.57	4.0
Boro	293.44	62.3	215.40	41.6	508.84	51.5
Local boro	39.72	8.4	19.44	3.8	59.16	6.0
Modern-variety boro	184.26	39.1	25.91	5.0	210.17	21.3
Wheat	8.57	1.8	22.03	4.3	30.60	3.1
Pulses	16.62	3.5	110.43	21.3	127.05	12.8
Oilseeds	26.30	5.6	14.85	2.9	41.15	4.2
Vegetables	9.51	2.0	11.04	2.1	20.55	2.1
Spices	6.89	1.5	8.99	1.7	15.88	1.6
Other	1.58	0.3	2.72	0.5	4.30	0.4
Total sown area	707.02	150.1	710.68	137.2	1,417.70	143.4
Total cultivated area	470.95	100.0	517.91	100.0	988.86	100.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.
Note: Parts may not add to totals because of rounding.

crops are grown on about 31 percent of the unirrigated land, but on only about 4 percent of the irrigated land. Owing to the large-scale replacement of noncereal crops by rice, the effect of irrigation on intensity of land use is much less pronounced than its effect on cereal cultivation. The sown area under cereals is about 87 percent of cultivated land for the unirrigated plots; with irrigation the proportion rises to about 153 percent—an increase of over 66 percent. The total cropping intensity is, however, estimated at 165 percent for the irrigated land, compared with 132 percent for unirrigated land—an increase of only 33 percent.

Table 26 compares the patterns of land use in sample villages that are classified into two equal-size groups according to the scale of diffusion of the new agricultural technology (see Chapter 2). MV rice is grown on almost 80 percent of the cultivated land in the developed villages, compared with only 8 percent of the land in underdeveloped villages. For the aus and boro seasons together, the proportion of cultivated land under MV rice in both groups of villages is similar to the proportion of area irrigated, indicating a singular relationship between irrigation and adoption of MV seeds. This supports the findings of strong complementarity between the two inputs reported in Chapter 3 on the basis of regression analysis of district cross-section data. Intensity of land use is estimated at about 150 percent for the technologically developed villages, compared with 137 percent for the underdeveloped villages. Thus a 40 percent increase in irrigation leads to a 13 percent increase in effective supply of land, indicating an elasticity of supply of land to irrigation of 0.33.

Productivity of Land and Labor

A technique frequently used to analyze productivity and efficiency of resource use is the Cobb-Douglas production function. The technical coefficients of production estimated from the function are used in various policy applications. The input coefficients of the function represent production elasticities of the inputs. The sum of the elasticities is used as an indicator of the degree of returns to scale in production. This section uses the farm-level cross-section data for 1982 to estimate production functions for the traditional and modern varieties of rice in order to study the effect of the new technology on productivity of land and labor.

The production function for each crop was fitted in the following form:

$$\mathrm{Ln}Y_i = \mathrm{Ln}\beta_0 + (\beta_1 + \beta_2)\mathrm{Ln}A_i + \beta_2\mathrm{Ln}(N/A)_i + \sum_{j=1}^{15} \lambda_{ij}V_{ij} + V_iD_i, \qquad (1)$$

where Y_i is the value added (Tk) for the ith farm in the cultivation of the crop, as measured by the gross value of output net of the costs on account of seeds, manure, fertilizer, pesticides, and irrigation. The cost of animal labor could not be included owing to nonavailability of data. Ln is the natural logarithm of the variable, A is the amount of land sown under the crop, and N is the total number of labor days (hired plus family labor) used during the production period (from land preparation to threshing). A number of crops were affected by droughts, floods, and hailstorms during the year, and the effect was not uniform across villages or across farms within a village (owing to variations in land elevation). Information was collected from every farmer about the amount of crop damage as a percentage of the harvest expected, given the extent of application of the inputs. This farm variable, D_i, has been used to dissociate the effect of natural calamities. Since the information comes from 16 widely scattered villages in different ecological zones, it is expected that the variation in climate, soil type, and intensity of land use permitted by these agroclimatic factors would contribute to some variation in output, irrespective of the amount of inputs used. Therefore 15 village dummy variables, V_j, have been used to dissociate the effect of the environmental factors. The coefficients β_1 and β_2 are the output elasticity of land and labor, respectively. The coefficient of $\mathrm{Ln}A_i$ gives the sum of the elasticities, which, along with its standard error of estimate, can be used to test the hypothesis about the degree of returns to scale in the specific crop-production activity.

Equation (1) is a modified form of the general Cobb-Douglas production function,

$$\mathrm{Ln}Q_i = \mathrm{Ln}\beta_0 + \sum_{j=1}^{m} \beta_i \mathrm{Ln}X_{ij}, \qquad (2)$$

where for the ith farm, Q is the gross output, and X_j is the amount of the m different inputs used in its production. This particular functional form assumes that the elasticity of substitution between any two inputs is equal to one. Value added is used instead of gross output and is related only to the primary inputs, land and labor, for the following reasons. Seed is an important material input, but it has a technologically fixed relationship with land, which violates the unit elasticity of substitution assumption. The variation in the amount of fertilizer used per unit of land in individual crop varieties is limited to a certain range. Changes in the use of fertilizer are realized more through choice of crop varieties. Animal power is an important input, but it is used along with human labor, which produces strong complementarity rather than substitutability assumed in the production function. Inputs like fertilizer and irrigation are also complements rather than substitutes. Fertilizer, manure, pesticides, and irrigation are not essential for production of local varieties: this is indicated by the small proportion of farmers applying these inputs (see Chapter 4). The log-linear production function is not appropriate if these inputs are used as explanatory variables. Thus deduction of the costs on account of the material inputs from the gross value of production appears more appropriate than using them as separate variables in the Cobb-Douglas production function framework.

Since farm-level cross-section data are used to estimate the function, one expects the amount of land and labor to be highly correlated across farms. This creates the well-known problem of multicollinearity in estimating the parameters of the function. To avoid this problem, the labor input has been measured per unit of land, which breaks the high degree of correlation between land and labor. This produces the modified form of the function as shown in equation (1), in which the coefficient of logarithm of the land variable becomes the sum of the elasticities of land and labor.

The estimates of the parameters of the function obtained from use of the OLS method are reported in Table 27. The following major conclusions can be drawn from the findings.

Crops are significantly affected by damage due to natural factors. The coefficient of damage is statistically significant for all crop varieties. This indicates the prevalence of a high degree of uncertainty in rice cultivation, so the farmer cannot be sure about the productivity of the inputs applied on the land. Thus the rate of application of the inputs may depend not only on the prices but also on the degree of risk aversion of the farmer. The regression coefficient of crop damage is, however, found to be lower for MVs than for traditional varieties in all three seasons.

Table 27—Estimates of Cobb-Douglas production functions for different varieties of rice, 1982

Season/ Variety	Constant	Elasticity[a]		Coefficient of Crop Damage	$\bar{R}^2$	'F' Statistic
		Land	Labor			
Aus						
Local	5.640 (0.980)	0.511 (0.055)	0.555 (0.190)	−1.41 (0.19)	0.82	59.0
Modern	7.364 (0.852)	0.701 (0.062)	0.338 (0.190)	−0.86 (0.31)	0.89	98.6
Aman						
Local	6.110 (0.474)	0.570 (0.060)	0.490 (0.120)	−0.86 (0.12)	0.82	46.9
Modern	7.701 (0.417)	0.636 (0.053)	0.374 (0.100)	−0.54 (0.18)	0.83	66.9
Boro						
Local[b]	7.280 (0.298)	0.787 (0.028)	0.296 (0.080)	−1.13 (0.14)	0.96	720.0
Modern	7.196 (0.262)	0.613 (0.023)	0.371 (0.063)	−0.69 (0.08)	0.93	669.4

Notes: Figures in parentheses are standard errors of the estimated coefficients. The regression coefficients of village dummies have not been reported.

[a] The standard error of estimate is for the sum of the elasticity of land and labor.

[b] Local boro is grown in only one ecological zone. Hence the village dummies have not been used.

The sum of the output elasticity (factor share) of land and labor is less than one for MV boro and greater than one for other varieties. But except for local boro, the value is not statistically significantly different from unity. This indicates the existence of constant returns to scale in rice cultivation.

The elasticity of land is generally higher, and that of labor lower, for the cultivation of MVs than for traditional varieties. Only in the case of the boro season is elasticity of labor found to be higher for MVs than for local varieties. In the boro season, boro MVs compete for land with local aus (grown on high land) more than with local boro (grown on extremely low land). Compared with local aus, the elasticity of labor is lower for MV boro.

The estimates of marginal productivity of land and labor, at the mean level of application of the inputs, are reported in Table 28. In estimating the marginal productivity of land, the output elasticity of land is taken as the difference of the elasticity of labor from unity, since constant returns to scale prevails. The table also compares the value of the marginal productivity of land with the rent paid by sharecroppers to landowners, and the value of labor with the average farm-specific wage rate paid to hired casual laborers in the cultivation of crops during the survey year. The following major points can be noted from the table.

Compared with local aus, the marginal product of land is about 5.3 times higher in the cultivation of MV aus and 4.8 times higher in the cultivation of MV boro. In the aman season, the increase in the marginal product in MV cultivation is less, but compared with the local variety, it is still about 2.2 times higher. In the boro season, however, the increase in productivity from use of modern technology is only about one-twelfth, but compared with local aus, which is the main substitute crop, the productivity increase is about 4.8 times. Thus modern technology gives tremendous scope for increasing the net returns from the fixed endowment of land that the farmer has.

The effect of modern technology on increasing the productivity of labor is small. Compared with local varieties, the marginal product of labor is higher for MVs by about 51 percent for the aus season, 41 percent for the boro season, and only 5 percent for the aman season. The difference would not be statistically significant, as indicated by

Table 28—Estimates of average and marginal products of land and labor, crop level, 1982

Season/ Variety	Land		Labor		Rent[a]	Wage Rate[b]
	Average Productivity	Marginal Productivity	Average Productivity	Marginal Productivity		
	(Tk/acre)		(Tk/day)		(Tk/ acre)	(Tk/ day)
Aus						
Local	1,302	579	23.25	12.90	841	12.92
Modern	4,613	3,054	57.66	19.49	2,596	17.64
Aman						
Local	2,371	1,209	43.91	21.52	1,418	20.09
Modern	4,342	2,718	60.30	22.55	2,390	21.75
Boro						
Local	3,627	2,553	44.23	13.09	2,022	20.00
Modern	4,386	2,759	49.84	18.49	2,897	23.88

Source: Estimated from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey data.

[a] The value of rent is based on actual production, share rental, and input shares received from landowners in the cultivation of rental land.

[b] These are average farm-specific wage rates paid to hired workers in the cultivation of the crop.

the high standard error of estimate of the elasticity of labor (Table 27). It may also be noted that most of the increase in the marginal product of labor is passed on to workers in the form of higher wages. The workers, however, gain more through additional employment under the new crops (Chapter 4).

Efficiency in the allocation of resources is determined by comparing the marginal product of the factor with its price. According to neoclassical theory, allocation of resources is at optimum when the marginal product of the resources is equal to their prices. In Bangladesh, under sharecropping—the most common tenancy arrangement—the tenant pays 50 percent of the gross produce as rent to the landowner. In the cultivation of MVs, the landowner sometimes shares half the cost of fertilizer and irrigation.[61] The survey found that less than 1 percent of the cost of material inputs was paid by the landowner. The value of rent reported in Table 28 is based on actual production of rented-in land, rent paid by the tenant, and the input cost shared by the landowners. For aus and aman varieties, the marginal product of land is lower than the rent for the local varieties, indicating that the tenants have to pass on a portion of the return on their labor in the form of rent in order to get the land. For MVs, the marginal product of land is higher than the rent—14 percent for the aman season and 18 percent for the aus season. Thus the tenants tend to gain with the diffusion of modern technology in these seasons. For the boro season MVs, however, the marginal product of land is lower than the rent.

Labor seems to be optimally allocated during the aus and aman seasons, as its marginal product is almost in line with the wage rate for the four crop varieties grown during these seasons. During the boro season, however, the marginal product is lower than the wage rate, indicating overutilization of this input. This is usually the slack season of agricultural activity. Nearly half of the land remains fallow during the boro season (Table 26). Only about one-fourth of the land is cultivated with rice. Pulses and oilseeds, which are low-labor-intensive, are the major crops grown during the season. It appears from the findings that farmers facing underemployment of family workers are willing to accept low returns for labor during this season.

Relative Economic Efficiency

In recent economic literature, a profit function model, derived by the application of duality relation between the cost and the production function, is used to measure and compare economic efficiency and price efficiency for groups of farms.[62] Although the model has been severely criticized,[63] its use for empirical studies remains popular. The model is appropriate for the present analysis, as farm households can be classified into two groups, adopters and nonadopters of the modern technology, and their relative economic efficiency compared.

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[61] M. Raquibuz Zaman, "Sharecropping and Economic Efficiency in Bangladesh," *The Bangladesh Economic Review* 1 (No. 2, 1973): 149-172. It is found from this survey that 39 out of 72 farmers who cultivated modern-variety boro on rented land received some input from the landowner, but the value of the landowner-supplied input was only 0.8 percent of the cost on account of seeds, fertilizer, irrigation, and pesticides. The incidence of cost-sharing was even less for other crops.

[62] Pan A. Yotopoulos and Lawrence J. Lau, "A Test for Relative Economic Efficiency," *The American Economic Review* 63 (No. 1, 1973): 214-223.

[63] See, for example, John Quiggin and Anh Bui-Lan, "The Use of Cross-Sectional Estimates of Profit Functions for Tests of Relative Efficiency: A Critical Review," *Australian Journal of Agricultural Economics* 28 (No. 1, 1984): 44-55; and Ramesh Chand and J. L. Kaul, "A Note on the Use of the Cobb-Douglas Profit Function," *American Journal of Agricultural Economics* 68 (No. 1, 1986): 162-164.

In the model, farms are assumed to have fixed endowments of land, L, and capital, K, which cannot be varied in the short run, but farms can choose variable inputs, labor, N, and fertilizer, F, whose prices are W and C, respectively.[64] The amount of variable inputs that the farm decides to use is determined by setting the marginal cost of the input i to $1/P_i$ times the marginal value product, where P is considered the opportunity cost of the input supplied from the farm family. Farms are called price efficient if all the P_i are equal to unity. One farm may be more technically efficient than another if it produces a larger quantity of output from the same quantities of measurable inputs. Technical efficiency may differ between two groups of farms by a multiplicative factor, δ. Differences in economic efficiency among groups of farms may be caused by differences in technical or price efficiency or both.

Under the assumption of Cobb-Douglas technology, the model yields a unit output price (UOP) profit function:[65]

$$\mathrm{Ln}\pi = \mathrm{Ln}A + \delta T + \alpha_1 \mathrm{Ln}W + \alpha_2 \mathrm{Ln}C + \beta_1 \mathrm{Ln}L + \beta_2 \mathrm{Ln}K, \tag{3}$$

and input demand equations:

$$-WN/\pi = \alpha_{11}T + \alpha_{12}(1-T) \quad \text{and} \tag{4}$$

$$-CF/\pi = \alpha_{21}T + \alpha_{22}(1-T), \tag{5}$$

where π is the unit output price profit (gross revenue minus total variable cost), W and C are, respectively, labor and fertilizer prices normalized by the output price, and T is a dummy variable taking value 1 for MV adopter farms and 0 for nonadopters.

The hypothesis of equal relative economic efficiency implies that δ is equal to zero. The hypothesis of equal relative price efficiency implies that $\alpha_{11} = \alpha_{12}$ and $\alpha_{21} = \alpha_{22}$. The hypothesis of absolute price efficiency implies that for adopter farms, $\alpha_{11} = \alpha_1$ and $\alpha_{21} = \alpha_2$, and for non-adopter farms, $\alpha_{12} = \alpha_1$ and $\alpha_{22} = \alpha_2$.

The error terms are assumed to be additive with zero expectation and finite variance for each of the three equations. But the covariances of the error of either equation corresponding to different farms are assumed to be identically zero. Under this specification of errors, Zellner's seemingly unrelated regression equation (SURE) provides an asymptotically efficient method of estimation.[66] The efficiency of estimation can be increased by imposing known constraints on the coefficients in the equation.[67]

In estimating the model from the data, profits have been measured by deducting farm-specific costs of variable inputs—seed, fertilizer, manure, pesticides, irrigation, and labor—from the gross value of output. The cost of animal labor could not be counted because of nonavailability of data. It has been treated as a fixed input and included in farm capital. The cost of family labor has been imputed by the wage rate paid to hired workers. It was mentioned earlier that the market for irrigation was very imperfect, and the irrigation charge varied widely depending on the source of supply of water. Since the MV crops were irrigated (Chapter 4), the cost of irrigation was also imputed by multiplying the area under MVs by the average cost of irrigation per unit of land for the entire sample. The prices of variable inputs at the farm level could be computed only for labor and fertilizer, since information on both quantity and cost was available only for these two inputs. For this reason, only fertilizer and labor could be used as variable inputs on the right-hand side of the profit equation. A significant proportion of farmers (9.5 percent) did not hire labor or use chemical fertilizer, so prices could not be computed for them. These cases have been dropped because of the nonavailability of farm-specific prices. The profits, wage rate, and fertilizer price variables have been normalized by paddy prices. The capital input has been measured in flow terms by multiplying the replacement cost of the stock of agricultural implements and draft animals by the rate of interest charged on loans from commercial banks.

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[64] The profit function is estimated for the sample farm households for all crops taken together. Since over 90 percent of the farmers used fertilizer on one crop or another, fertilizer was included as a variable production input, since output elasticity of fertilizer is often used as an important parameter in policy analysis (such as estimating costs and benefits of fertilizer subsidy). Also, information on farm capital was available at the household level and not at the crop level, so this variable could be included in the profit but not in the crop-specific production function reported earlier.

[65] For details of the derivation, see Yotopoulos and Lau, "A Test for Relative Economic Efficiency," pp. 215-218.

[66] A. Zellner, "An Efficient Method for Estimating Seemingly Unrelated Regressions and Test for Aggregation Bias," *Journal of the American Statistical Association* 57 (No. 2, 1962). 348-368.

[67] Yotopoulos and Lau, "A Test for Relative Economic Efficiency," p. 219.

Because of widespread crop damage from natural calamities during the reference year of survey, and the use of the wage rate as the opportunity cost of family labor, the profits were negative for a large number of cases (99 out of 475 farms in the sample). Since the UOP profit function is log linear, these cases had to be excluded. Since lower profits may also be due to inefficiency of resource use, this might introduce sample selection bias in the results. It is found from the tests of the difference of arithmetic means that farms making negative profits are one-third smaller in size and use 48 percent less fertilizer, but are not significantly different in adoption of modern varieties and use of capital services when compared with farms making profits (Table 29).

A major criticism of the model is that the invariability of the prices in the cross-section data vitiates the usefulness of the methodology.[68] This is not found to be a serious problem for the data set used here. Since the sample was selected from a large number of villages scattered throughout the country, and a number of villages are located in

Table 29—Selected characteristics of profitable and unprofitable sample farms, 1982

Variable	Farms Showing Profit (N = 331)	Farms Showing Loss (N = 99)	Percent Difference[a]	Estimated t-Value	Level of Significance
	(acres)				
Average amount of land owned	3.10	1.97	−37	−2.95	0.003
	(percent)				
Cropped area under modern varieties	36	37	1	0.28	0.777
	(kilograms)				
Fertilizer use per acre of cropped land	78	41	−48	−4.02	0.000
	(Tk)				
Capital services per acre of cropped land	298	334	12	0.61	0.543

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Values for farms showing losses over those for farms showing profits.

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[68] Quiggin and Bui-Lan, "Use of Cross-Sectional Estimates," pp. 44-45.

interior areas with underdeveloped infrastructural facilities, differences in prices across locations were quite significant, particularly for labor and fertilizer. The coefficient of variation of prices across villages was found at 24 percent for labor, 14 percent for fertilizer, and 7 percent for paddy.[69]

The results of the tests of various hypotheses regarding the absolute and relative price efficiency in the use of labor and fertilizer, and also of constant returns to scale in production, are presented in Table 30. The hypothesis that the price efficiency is the same for the adopter and nonadopter farms is accepted for labor but rejected for fertilizer. The χ^2 value for the equality of the parameters in the fertilizer demand equation for the two groups is highly statistically significant. Both groups are absolutely price inefficient in the use of labor and fertilizer. But when the hypothesis of equal relative efficiency in the use of labor is maintained, both groups appear to be absolutely price efficient in the use of fertilizer. The hypothesis of constant returns to scale is also accepted.

The estimates of the parameters of the profit function and the factor share equations are presented in Table 31. The technology dummy is found to be highly statistically significant and the value of the parameter is positive, indicating that the adopter farms are more economically efficient. Even under the assumption of equal price efficiency for labor and constant returns to scale, the technology dummy remains statistically significant, the value indicating that the adopter farms are also more economically efficient, compared with the nonadopter farms, by about 29 percent.

In estimating profits, the cost of family labor was imputed at the wage rate paid to hired workers. This may be a very restrictive assumption, as the opportunity cost of labor could vary across farms, depending on the availability of family labor. To see the bias created by this assumption another explanatory variable was incorporated in the

Table 30—Tests of hypothesis of relative and absolute price efficiency and constant returns to scale

Test	Parameter Restriction	χ^2 Value	Significance Level
Relative efficiency in use of labor	$\alpha_{11} = \alpha_{12}$	1.19	0.275
Relative efficiency in use of fertilizer	$\alpha_{21} = \alpha_{22}$	7.85	0.005
Absolute efficiency in use of labor	$\alpha_{11} = \alpha_1$ $\alpha_{11} = \alpha_{12}$	8.25	0.016
Absolute efficiency in use of fertilizer	$\alpha_{21} = \alpha_2$ $\alpha_{21} = \alpha_{22}$	7.86	0.020
Absolute efficiency in use of fertilizer for adopter farms maintaining equal relative efficiency in use of labor	$\alpha_{21} = \alpha_2$ $\alpha_{11} = \alpha_{12}$	1.19	0.549
Absolute efficiency in use of fertilizer for nonadopter farms maintaining equal relative efficiency in use of labor	$\alpha_{22} = \alpha_2$ $\alpha_{11} = \alpha_{12}$	1.31	0.518
Constant returns to scale	$\alpha_{11} = \alpha_{12}$ $\alpha_{21} = \alpha_2$ $\beta_1 + \beta_2 = 1$	5.09	0.166

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[69] The price variations are almost of a similar range to those reported in a study of Philippine rice growers by J. Flinn, K. Kalirajan, and L. Castillo, "Supply Responsiveness of Rice Farmers in Laguna, Philippines," *Australian Journal of Agricultural Economics* 26 (No. 1, 1982): 39-48.

Table 31—Joint estimates of profit functions and input demand equations, 1982

Variable (Parameter Restriction)	Parameter	Unrestricted Equation	Restricted ($\alpha_{11} = \alpha_{12}$ $\alpha_{21} = \alpha_2$ $\beta_1 + \beta_2 = 1$)	Restricted ($\alpha_{11} = \alpha_{12}$ $\alpha_{22} = \alpha_2$ $\beta_1 + \beta_2 = 1$)
Profit function				
Constant	LnA	−0.368 (−0.97)	−0.824 (−2.76)	−0.807 (−2.71)
Technology dummy	δ	0.258 (2.50)	0.282 (2.92)	0.288 (2.98)
Log wage rate	α_1	−0.368 (−2.52)	−0.312 (−2.21)	−0.305 (−2.15)
Log fertilizer price	α_2	−0.179 (−0.52)	−0.158 (−6.31)	−0.058 (−1.93)
Log land	β_1	0.767 (11.95)	0.882 (33.14)	0.882 (33.14)
Log capital services	β_2	0.128 (4.73)	0.118 (4.44)	0.118 (4.44)
Labor demand				
Adopter dummy	α_{11}	−1.058 (−5.52)	−0.953 (−0.582)	−0.956 (−5.83)
Nonadopter dummy	α_{12}	−0.653 (−2.06)	−0.953 (−5.82)	−0.956 (−5.84)
Fertilizer demand				
Adopter dummy	α_{21}	−0.172 (−6.09)	−0.158 (−6.31)	−0.158 (−6.31)
Nonadopter dummy	α_{22}	−0.019 (−0.40)	−0.058 (−1.89)	−0.058 (−1.93)
χ^2 for restriction	. . .	. . .	5.08	5.32
Level of significance	. . .	. . .	0.166	0.150

Note: Figures in parentheses are asymptotic t-values, $\bar{R}^2 = 0.50$, and the sample size consists of 331 profit-making farms.

profit function, FLBR, which is measured by the proportion of labor supplied from the farm family. If the opportunity cost of labor depends on the availability of family labor, this variable should be a proxy of the price of family labor. If the variable is statistically significant, the hypothesis that the opportunity cost of family labor is equal to the wage rate can be rejected.

The unrestricted joint estimates of the profit function and the labor demand relations are as follows:

$$\begin{array}{lllll} \text{Ln}\pi = & -0.274 & +\ 0.343\,\text{T} & -\ 0.698\,\text{LnW} & -\ 0.195\,\text{LnC} \\ & (0.71) & (3.26) & (-5.33) & (-0.50) \\ & +\ 0.702\,\text{LnL} & +\ 0.122\,\text{LnK} & -\ 0.702\,\text{FLBR}; & \\ & (10.6) & (3.26) & (3.85) & \end{array} \qquad (6)$$

$$\bar{R}^2 = 0.52, \quad N = 331;$$

$$WN/\pi = -1.05\,T - 0.65\,(1 - T), \text{ and} \quad (7)$$
$$\qquad (-5.52) \quad (-2.05)$$

$$WC/\pi = -0.171\,T - 0.019\,(1 - T). \quad (8)$$
$$\qquad (-6.09) \quad (-0.40)$$

The figures within parentheses are asymptotic t-values.

The coefficient of FLBR is negative and highly statistically significant. Thus the estimated profits decline with increased use of family labor, indicating that the opportunity cost of family labor is lower than the wage rate. Inclusion of this variable increases the value of the coefficient of the price of labor (LnW) from −0.37 in the previous estimate (Table 31) to −0.70. Since family labor has been incorporated as a separate variable, W can now be interpreted as the price of hired labor. The hypothesis that the value of parameter (α_1) is equal to the parameters of the labor demand relation ($\alpha_{11} = \alpha_{12}$) was also tested. The tests produced a χ^2 value of 2.59 with a significance level of 0.17, which can be taken to mean that the farmers are absolutely price efficient in the use of hired labor.

Maintaining the hypothesis that the farmers are both absolutely and relatively price efficient in the use of hired labor and that constant returns to scale prevails, the following estimate of the profit function is produced:

$$\begin{aligned} Ln\pi \; = \; & -1.378 + 0.331\,T - 0.747\,LnW - 0.073\,LnC \\ & (-5.73) \quad (3.28) \quad (-7.38) \qquad (-0.20) \\ + \; & 0.895\,LnL + 0.105\,LnK - 0.570\,FLBR. \qquad (9) \\ & (34.13) \qquad (3.28) \qquad (-3.24) \end{aligned}$$

The coefficient of FLBR suggests that a 10 percent increase in the proportion of family labor reduces profits by 5.7 percent. Even after incorporating the effect of the lower cost of family labor, the coefficient of the technology variable (δ) remains positive and highly statistically significant. The value of the coefficient indicates that the adopter farms get about 33 percent more output from a given level of input than the nonadopter farms.

The output elasticity of various inputs for the Cobb-Douglas production function can be derived indirectly from joint estimates of the parameters of profit function and input demand equations. The estimates are statistically more consistent than the ones derived from the direct estimates of the Cobb-Douglas production function, which assumes all inputs to be exogenously determined, while in practice the variable inputs may be simultaneously determined, depending on prices, which is the maintained assumption in the profit function model. Since α_1 and α_2 appear in both the profit function and the respective input demand equations, imposing the restriction that they are equal in both equations, the efficiency of the estimates is improved. The parameters can also be estimated by imposing the condition of constant returns to scale ($\beta_1 + \beta_2 = 1$). In the estimates derived from equation (7) (unrestricted), the elasticity of land is 0.37, compared with a 50 percent share rental paid by sharecroppers to landowners in Bangladesh. It renders a marginal return of Tk 2,000 per acre. The elasticity of fixed nonland capital assets is estimated at 0.06, showing the relative unimportance of this input, which yields a return of Tk 1.1 per unit of investment. The elasticity for hired labor is 0.37, which yields a marginal productivity of Tk 22.00 per day of labor against an average wage rate of Tk 19.50 paid by the sample farms. The elasticity of fertilizer is estimated at 0.10, which gives a marginal return of Tk 2.10 per unit of taka investment in this input.

The estimate from the unrestricted profit function thus shows considerable inefficiency in the allocation of fertilizer. As indicated earlier, the inefficiency is mainly due to farms that produce local varieties on which fertilizer is used in small amounts. The new crops are not only more technically efficient, they allow farmers to achieve higher levels of allocative efficiency by creating conditions to use more fertilizer per unit of land.

Conclusions

Diffusion of the modern technology increases the effective supply of land by reducing the proportion of fallow land during the dry season. The sown area under cereals is about 87 percent of the cultivated land for unirrigated plots—on irrigated plots it is 150 percent. The increase in the intensity of cereal cultivation is partly at the expense of other crops. Pulses, jute, and sugarcane are grown on about one-third of the unirrigated land, but only 4 percent of the irrigated land is allocated to these crops. With the provision of irrigation facilities, the cropping intensity of the land increases by one-third.

Technological diffusion would increase marginal returns from land many times and provide scope to the landowner to earn more from this scarce resource through the gradual reallocation of land from local to modern varieties. The increase is about five times for the aus and boro seasons and 2.2 times for the aman season. The marginal product of labor is almost the same for the alternative varieties in the aman season, but in the aus and boro seasons the productivity is higher by about 50 percent for the modern varieties. Labor tends to gain more from additional employment than from the increase in marginal product.

The adopters of the new technology are absolutely price efficient in the allocation of fertilizer compared with the nonadopters, but both groups are absolutely price inefficient in the use of labor. The inefficiency in the use of labor is mainly due to low opportunity cost of family labor. The marginal product of hired labor is found to be close to the wages paid. The adopter farms are more technologically efficient than the nonadopter farms by about 33 percent. Diffusion of the new technology would thus improve the efficiency of resource utilization in agriculture.

6

FARM SIZE, TENANCY, AND ADOPTION OF MODERN TECHNOLOGY

A crucial factor in determining equity implications of the new rice technology is the extent and intensity of its adoption among different groups of farmers. The literature is full of studies that analyze adoption behavior of farmers to test the hypothesis that gains from the introduction of the new agricultural technology have been unequally distributed.[70] Most of the evidence for the early period of the green revolution suggests that the incidence of adoption is positively related to farm size, which appears counterintuitive, given the evidence that the new technology is seemingly scale neutral. It is argued that the new technology may entail some fixed costs in the form of access to information and sources of supply of the new inputs, and arrangements for marketing, which tend to discourage adoption by small farmers.[71] The role of tenurial arrangements in the adoption decision is also a subject of considerable controversy. A number of recent studies, however, argue that even if small farmers and tenants initially lag behind in adopting the new technology, they eventually catch up and ultimately may use it more than the large owner-farmers.[72] But even if this is the case, the early adopters can accumulate more wealth and power, which they can use for further accumulation of land from the laggards, thereby establishing a process of unequal distribution of income with the diffusion of the new technology.

To assess the equity implications of the modern technology for Bangladesh, this chapter studies adoption behavior among different size and tenurial groups of farmers and tests pertinent major hypotheses put forward in the literature. Major issues raised in the literature are outlined in the following section. Next, a descriptive account of the intensity of adoption among different groups of farmers is given. The factors affecting adoption are then analyzed, using multivariate regression techniques. The final section investigates the differences in land productivity and prices faced by different groups of farmers, since these also have a bearing on the income distribution effect of the new technology among farmers.

The Issues

The relationship between farm size and adoption of the new technology cannot be determined a priori. Farm size is often a surrogate for a large number of factors[73] that may have an important bearing on the adoption decision. Since the importance of these factors varies across space and over time, variant relationships between farm size and the rate of adoption are observed in empirical investigations.

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[70] This is in fact an overresearched issue. There are also a large number of surveys of the literature. See, among others, Lipton, *Modern Varieties;* Michael Lipton, "Inter-farm, Inter-regional and Farm-nonfarm Income Distribution: The Impact of the New Cereal Varieties," *World Development* 6 (No. 3, 1978): 319-337; Gershon Feder, Richard E. Just, and David Zilberman, "Adoption of Agricultural Innovations in Developing Countries: A Survey," *Economic Development and Cultural Change* 33 (No. 2, 1985): 255-298; M. Prahladachar, "Income Distribution Effects of the Green Revolution in India: A Review of Empirical Evidence," *World Development* 11 (No. 11, 1983): 927-944; and Richard Perrin and Don Winkelmann, "Impediments to Technical Progress on Small Versus Large Farms," *American Journal of Agricultural Economics* 58 (December 1976): 888-894.

[71] Pears, *Seeds of Plenty,* p. 120.

[72] Vernon W. Ruttan, "The Green Revolution: Seven Generalizations," *International Development Review* 19 (No. 4, 1977): 16-23.

[73] R. Albert Berry and William R. Cline, *Agrarian Structure and Productivity in Developing Countries* (Baltimore: Johns Hopkins University Press, 1979).

An important factor is the degree of risk aversion among farmers.[74] Apart from the objective risk of having uncertain returns on investment under conditions of weather variation and pest attacks, the new varieties entail in the initial years a subjective risk of having an uncertain yield with an unfamiliar technique, the full intricacies of which have not yet been mastered by the farmer. The more risk averse is the farmer, the less willing he will be to adopt, and even if he adopts, he will try to minimize the risk by devoting a smaller proportion of land to the new crops. The degree of risk aversion may depend on the farmer's income. If the farmer operates around the poverty level, he will want to ensure survival for self and family by avoiding the risk of falling below the subsistence level. Since farm size and income may be highly correlated, the small farmer may be more risk averse and less likely to adopt the new technology than is the large farmer. In the case of Bangladesh, a large majority of farmers operate near the subsistence level. But the new technology is now sufficiently known to the farmers and the objective risk is found to be lower for the new crops (Chapter 4), so the risk-aversion factor may not be important in explaining adoption behavior.

The need for working capital to cultivate a given amount of land is higher for the new crop varieties (Chapter 4). For farmers who need to invest in indivisible irrigation equipment like tubewells and power pumps, adoption of the new crops would also require a large initial fixed investment. So, unless the government bears the cost of irrigation development, access to capital in the form of accumulated savings or financial institutions may be an important determinant of the rate of adoption. In many low-income countries, small farmers have limited access to financial institutions. Thus the credit constraint may induce farmers to borrow from the high-cost noninstitutional sources. Working capital constraints may, however, be eased considerably after a few years if the small farmer can accumulate the incremental profits from cultivation of the new crops.

Access to information about sources of new inputs, knowledge about how they can be optimally used, and marketing of the additional output can also be an important factor in determining the differential rate of adoption.[75] The level of education of the farmer can be taken as a proxy of this variable. Since the opportunity cost of sending children to school rises with poverty, educational status is generally found to be positively related to farm size. The larger farmer who is better educated may have more contact with the extension agents who supply this information. Thus the large farmer is expected to have a higher rate of adoption.

A number of other factors may, however, operate to encourage more adoption among the smaller farmers. The new crops use substantially more labor input per unit of land. In rice cultivation, which depends more on the use of casual workers (hired on a daily basis), this labor requirement makes the problem of labor management more difficult and may prevent adoption of the new crop by relatively labor-scarce large farmers. If the new crop increases the seasonal demand for labor, it is less attractive to farmers with a limited supply of family labor.

According to the Chayanovian theory of peasant economy,[76] the consumption unit of the family in relation to the production unit (land and worker) may be an important determinant of the adoption of the new technology. This theory argues that the motive force behind the economic activity of a peasant family is the consumption need, which increases with the growth of the family. The peasant responds to the increased consumption requirement by substituting labor for leisure and by acquiring more land. In land-scarce countries, the possibility of accumulating land is limited for the peasant. In this situation, the yield- and income-raising technology provides the opportunity for increasing consumption from the same amount of land. Hence the new variety is more attractive to small farmers who have more family members relative to land.

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[74] Feder, Just, and Zilberman, "Adoption of Agricultural Innovations," pp. 262-265.

[75] Pears, *Seeds of Plenty.*

[76] A. V. Chayanov, *The Theory of Peasant Economy*, ed. David Thorner (Homewood, Ill.: Richard D. Irwin, 1966).

The impact of tenurial arrangement on adoption decision is a matter of considerable controversy in the theoretical literature.[77] Bhaduri, citing the East Indian experience, argues that the landlord who derives income from rent as well as from usury is interested in keeping tenants perpetually indebted. Under these circumstances, it is in the landlord's interest not to allow tenants to adopt the new technology, since higher incomes from cultivation of the same amount of land would reduce the tenants' indebtedness, and the loss in usury income would outweigh the gain in rental income accruing to the landlord. This hypothesis has, however, been criticized on the ground that if the landlord has sufficient monopoly power to withhold adoption of the new technology, it should also be possible to siphon off the extra income of the tenant by increasing the rent. Newberry argues that under uncertain labor and product markets, sharecroppers would be interested in adopting the new technology. But Bardhan shows through a theoretical model that land-augmenting technical change and higher labor intensity—the characteristics of the new rice varieties—would induce a higher incidence of tenancy. The risk-aversion theory implies that share tenancy may be a preferred arrangement for adoption of the new technology, since the risk can be shared by the tenant and the landlord. Also, since the tenant is usually a small farmer with more surplus labor and higher subsistence pressure, adoption of the new technology may be easier for the tenant than for the owner-cultivator.

The availability of complementary inputs can also influence adoption behavior. In the case of new varieties of rice, an important factor is the assured and regulated supply of water (that is, irrigation) without which the new variety would be more risky and less profitable. In Bangladesh, with small farms and fragmented and scattered holdings, irrigation seems to be exogenously determined, since the facilities are developed by the government largely with externally funded projects. Even with private ownership of irrigation equipment by large landowners, which has increased somewhat since the late 1970s, the small and medium farmers have an equal chance of having some of their plots located within the command area because of the random location of fragmented holdings. Under these circumstances, the differential adoption among farmers and regions would depend on the location of irrigation projects and on access of the different groups of farmers to irrigation facilities.

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[77] Amit Bhaduri, "A Study in Agricultural Backwardness under Semi-feudalism," *Economic Journal* 83 (March 1973): 120-137; David Newberry, "Tenurial Obstacles to Innovations," *Journal of Development Studies* 11 (July 1975): 263-277; Ajit K. Ghose and Ashwani Saith, "Indebtedness, Tenancy and the Adoption of New Technology in Semi-feudal Agriculture," *World Development* 4 (April 1976): 305-320; Pranab K. Bardhan, "Agricultural Development and Land Tenancy in a Peasant Economy: A Theoretical and Empirical Analysis," *American Journal of Agricultural Economics* 61 (No. 1, 1979): 48-56; and Pranab K. Bardhan and T. N. Srinivasan, "Crop Sharing Tenancy in Agriculture: A Theoretical and Empirical Analysis," *American Economic Review* 61 (No. 1, 1971): 48-64.

Pattern of Adoption

Farm Size and Adoption of MVs

Table 32 summarizes the observed pattern of adoption of new crop varieties among different groups of sample farmers in the study villages. About three-fourths of the farmers cultivated the new varieties, although only about one-third of the sown area was allocated to them. The proportion of adopter farmers is not found to be significantly different among different size and tenurial groups. The gains from the new technology thus appear to be widely distributed, irrespective of the landholding and tenurial status of the farmer.

The intensity of adoption is, however, found to vary inversely with farm size. The farmers who own less than 2.5 acres of land (henceforth called small farms) devoted about 43 percent of the cropped area to modern rice varieties; among farmers who own 5.0 acres or more (large farms), the proportion was 33 percent. The same pattern is observed even if the intensity of MV adoption is measured as a proportion of sown area under rice. The result appears contradictory to the general findings on this issue in the South Asian context. The previous studies on the extent of adoption for Bangladesh, however, found a similar pattern. One of the more rigorous earlier studies (based on data for 1972), conducted by Asaduzzaman, found that small farmers devoted about 28 percent of the aman rice area to the new crops compared with only 14 percent for large farmers.[78] Herdt and Garcia reviewed findings of seven studies conducted between 1969 to 1981 and noted that five of these reported higher intensity of adoption among smaller farmers.[79] The 1983-84 agricultural census also supports this finding.[80] The census found about 26 percent of the net cropped area for the small farms was under rice MVs, compared with 23 percent for medium farms and 18 percent for large farms.

Table 32—Adoption of modern varieties of rice, by farm size and tenancy, 1982

Farm Group	Share of Farms Adopting Modern Varieties	Share of Area Under Modern Variety Rice: Total Cropped Area	Share of Area Under Modern Variety Rice: Rice Area
		(percent)	
Size of farm			
Small (less than 2.5 acres)	75	43.2	51.7
Medium (2.5–5.0 acres)	74	35.8	44.6
Large (5.0 acres or more)	77	32.5	42.4
Tenurial status			
Owner	77	35.7	44.1
Tenant or owner with tenants	74	38.1	48.1
All farms	75	36.8	46.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

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[78] M. Asaduzzaman, "Adoption of HYV Rice in Bangladesh," *The Bangladesh Development Studies* 7 (No. 3, 1979): 23-49.

[79] Herdt and Garcia, "Adoption of Modern Rice Technology."

[80] Bangladesh, *Census of Agriculture and Livestock.*

Tenancy and Adoption of MVs

The adoption of MVs is not found to be significantly different between owner and tenant farmers. In Bangladesh, pure tenants, that is, those who rent the entire holding, are rare. Most of the tenants are part-tenants who own some land and rent some to make the holding viable. As can be noted in Table 32, 75 percent of the owner-tenants cultivated some land with MVs, compared with 77 percent for the owner-cultivators. The intensity of adoption was about 38 percent for tenants, compared with 36 percent for owners. For rice, tenants devoted 48 percent of the sown area to MVs, compared with 46 percent for owners.

Table 33 shows the incidence of tenancy in the cultivation of different varieties of rice. It is found that tenants are the larger proportion of farmers cultivating MVs in all three rice-growing seasons. The proportion of area under tenancy is also found to be higher in the cultivation of MVs in all three seasons. This indicates a positive effect of the new technology on tenancy cultivation.

In Bangladesh the predominant tenancy arrangement is sharecropping, under which the gross output is shared equally between tenant and landowner, while most of the cost of cultivation is borne by the tenant.[81] It can be argued that under these circumstances, the tenant would be discouraged from adopting the new technology because he would have to bear the large incremental cost of labor, fertilizer, and irrigation, while the incremental output would be shared equally between tenant and landowner. The empirical observation thus appears inconsistent with this hypothesis. Under certain circumstances, however, the hypothesis cannot be tested by comparing the performance of the owner and tenant cultivator, particularly when the tenant also cultivates some owned land. If markets (such as those of labor and capital) are imperfect, the resource position of the cultivator may determine the opportunity cost, which would vary among cultivators. The tenant who has some underemployed resource (human or animal labor) that cannot be sold in the market may hire land. Since the new technology is labor-using, the tenant may want to maximize family income by devoting more land to the new crops than the owner-cultivator. The disincentive effect of share tenancy thus can only be assessed by comparing the rate of adoption on owned and sharecropped portions of the holding under the same cultivator. This is done in Table 34. It is noted that

Table 33—Incidence of tenancy, by season and technology, 1982

	Proportion of Farmers Renting Land		Rented Area as a Proportion of Sown Area	
Season	Traditional Variety	Modern Variety	Traditional Variety	Modern Variety
		(percent)		
Aus	24.6	30.7	14.3	15.9
Aman	27.9	44.7	19.0	20.1
Boro	16.0	35.0	7.5	16.9

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

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[81] Mahabub Hossain, "Nature of Tenancy Markets in Bangladesh Agriculture," *Journal of Social Studies* 3 (No. 1, 1979): 1-24; F. Tomasson Jannuzi and James T. Peach, *Agrarian Structure of Bangladesh: An Impediment to Development* (Boulder, Colo.: Westview Press, 1980).

Table 34—Adoption of modern varieties on owned and rented land for mixed-tenant farmers, by season, 1982

Season	Owner Farms	Owner-with-Tenant Farms	
	Share of Land Under Modern Varieties	Share of Owned Land Under Modern Varieties	Share of Rented Land Under Modern Varieties
		(percent)	
Aus	33.3	38.8	36.1
Aman	33.5	42.1	35.1
Boro	76.7	82.6	89.0
All seasons	44.1	49.8	46.5

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

tenants devoted a larger proportion of their owned land to MVs than did owner-cultivators, which is a reflection of the negative farm-size effect on MV cultivation, since most tenants are small farmers. But tenants allocated a smaller proportion of rented land than of owned land to the new crops during the aman and aus seasons. This distinction supports the hypothesis of disincentive effect of crop-sharing arrangements. Only during the boro season did tenants grow MVs more on their rented land than on their owned land. This may be due to a stipulation by the landowner that the land can be rented only if it is cultivated with MVs. It was found during the field survey that in many cases the land is only rented seasonally, and seasonal tenancy is more prevalent during the boro season.

Irrigation and Adoption of MVs

The sample villages under study differ widely in access to irrigation, types of irrigation, and length of experience with irrigation. In three villages located in Comilla District, irrigation facilities were developed and MVs introduced in the late 1960s during experimentation with the Comilla model of "cooperative capitalism." Two of the sample villages are under the Ganges-Kobtak project—the first large-scale irrigation project developed in Bangladesh—where irrigation is provided by gravity canals. These two villages got access to the irrigation canals in 1972. Two other villages irrigated part of the land by fielding low-lift pumps on canals developed by the food-for-work program in 1978. In another two villages, irrigation was introduced only two years before this survey by a few large landowners who invested in shallow tubewells. At the time of the survey, five villages did not have any access to irrigation facilities—three of them located in the coastal district of Khulna, where intrusion of saline water during the dry season makes irrigation development difficult. This diversity in the sample allows investigation of the role of irrigation in adoption among different groups of farmers in the early- and late-adopter villages.

The importance of irrigation in the adoption of MVs was shown earlier (Table 25) in the analysis of the pattern of land use for irrigated and unirrigated plots. Further analysis of the use of owner-operated plots shows the crucial importance of land elevation and access to irrigation in the intensity of adoption of MVs (see Table 35). Only 6 percent of the unirrigated plots were used for growing MVs, compared with 77 percent of the irrigated plots. MVs were grown much more on the plots located on the medium-elevation land than on extremely high and extremely low-lying plots, because the

Table 35—Adoption of modern varieties, by land elevation and access to irrigation facilities, 1981

Type of Land	Number of Plots in Sample	Plots Having Irrigation Facilities	Plots Not Growing Modern Varieties	Plots Growing Modern Varieties Once	Plots Growing Modern Varieties Twice
			(percent)		
Elevation					
Extremely high	1,063	14.6	89.6	7.7	2.7
Medium high	1,383	52.3	52.4	24.2	23.4
Medium low	941	44.3	62.3	33.0	4.7
Extremely low	181	16.0	83.4	13.3	3.3
Access to irrigation					
Unirrigated	2,242	0.0	94.0	5.5	0.5
Irrigated	1,326	100.0	23.0	47.4	29.6
All plots	3,568	37.2	67.6	21.1	11.3

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

physical characteristics of the extreme elevations do not generally allow regulation of water supply. About half of the plots located on medium-high land were reported to be irrigated, compared to only one-sixth of the plots located on extremely high and low-lying land. Almost one-third of the irrigated plots were used for growing MVs twice during the year, and it appears that land elevation is the most important factor determining intensity of use. More than 23 percent of the plots located on medium-high land were used to grow MVs twice during the year, compared with less than 5 percent for the other land categories. The second MV crop is grown during the monsoon season, so the low-lying plots that remain deeply flooded cannot be used to raise the dwarf MVs. Since the importance of the different types of plots in the landholding portfolio may vary across villages and farmers, the above findings point to the importance of dissociating the effect of physical characteristics of the land in analyzing the effect of socioeconomic factors on the adoption behavior of farmers.

Table 36 compares the pattern of adoption among different farm-size groups between irrigated and unirrigated villages. About 19 percent of the farmers in the unirrigated

Table 36—Adoption of modern varieties in irrigated and unirrigated villages, by farm size, 1982

Farm Size[a]	Share of Adopter Farms		Share of Cropped Area Under Modern Varieties	
	Unirrigated Villages	Irrigated Villages	Unirrigated Villages	Irrigated Villages
		(percent)		
Small	20	87	3.7	59.6
Medium	20	93	2.7	51.4
Large	15	93	0.7	49.5
All farms	19	90	2.2	53.5

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

villages allocated some land to MVs, compared with about 90 percent in the irrigated villages, where the proportion of adopters is 87 percent in the small-farm category and 93 percent among medium and large farms. Once irrigation facilities are developed in a village, the gains are widely distributed across the farm-size scale. Even in the late-adopter villages, where only about 27 percent of the cropped land is cultivated with MVs, more than 80 percent of the farmers are adopters (see Table 37). In the late-adopter villages, the smallest proportion of adopters is among small farmers, while in the early-adopter villages, almost all farmers grew MVs. This supports the contention that, with experience, small farmers catch up with the large ones.

The intensity of adoption is observed to be inversely related to farm size, even in the irrigated villages. About 54 percent of the cropped land in these villages is allocated to MV rice—60 percent for the small farms, compared with 50 percent among the large ones (Table 36). The inverse size effect prevails, even in the early-adopter villages (Table 37), indicating that the large farmers remained laggards even with the passage of time. Presumably, facing a shortage of family labor, the large farmers adopted MVs partly through tenants.

The type of irrigation itself may contribute to the differential rate of adoption among farmers. If the irrigation equipment is privately owned, as is often the case with tubewell irrigation in Bangladesh, a large-farmer monopoly in the supply of water can be expected, since the size of the command area and the high initial cost of investment would prohibit tubewell ownership by smaller farmers.[82] In this case, a direct relationship can be expected between farm size and adoption of MV rice. On the other hand, the communal development of irrigation, as in the case of the Water Development Board's large-scale canal irrigation project, may lead to a more egalitarian system of distribution of water supply, and other things remaining constant, the intensity of adoption would be invariant with farm size. To test this hypothesis, the rate of adoption along the farm-size scale was also estimated for different types of irrigation (Table 37). In the case of villages receiving water from canals, no systematic pattern of adoption was found, but with both tubewell and low-lift pump irrigation, the small farmers adopted more, which is contrary to the above hypothesis.

Table 37—Adoption of modern varieties by type of irrigation and length of experience, 1982

Village Group	Share of Adopter Farms			Share of Cropped Area Under Modern Varieties		
	Small Farms	Medium Farms	Large Farms	Small Farms	Medium Farms	Large Farms
	(percent)					
Type of irrigation						
Low-lift pumps	84	95	87	32.6	33.6	23.2
Canals	91	100	100	58.0	49.8	58.9
Tubewells	87	89	92	68.9	60.7	61.3
Length of experience						
Early adopter	98	100	100	74.8	69.3	71.3
Late adopter	79	88	85	29.6	26.5	24.9

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

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[82] Pears, *Seeds of Plenty*, p. 107.

Adoption of Fertilizers

Nearly nine-tenths of the sample farmers used fertilizers during 1982, although only about half of the plots were treated with fertilizers. The nonusers were mostly among those who grew only traditional varieties of rice. All farmers growing MV boro and aus rice, and 98 percent of those growing MV aman, used fertilizers. The proportion of user farmers was 74 percent for local transplanted aman, 73 percent for local aus, 19 percent for local broadcast aman, and only 6 percent for local boro. Fertilizer adoption is thus very much variety-specific and depends on the type of land and environment.

The pattern of adoption of fertilizers among different groups of farmers can be reviewed in Table 38. The adopter farmers are proportionately more among the larger size groups. But the intensity of use per acre of land is inversely related to farm size. This apparent inconsistency exists because the number of plots under cultivation is higher for the larger farmer, hence the probability of one of the plots falling under the command area of irrigation—and therefore being suitable for growing MV and applying fertilizer—grows with the size of the farm. The amount of fertilizer used per unit of land is thus a more appropriate indicator of adoption behavior than the proportion of user farms. Compared with large farmers, small farmers use about 35 percent more fertilizer per unit of cropped land, and medium farmers about 20 percent more. The extent of use is similar for owner and tenant farmers. Similar findings on differential adoption of fertilizer were noted by the IFDC from its countrywide survey.[83]

A major factor behind the inverse farm-size effect on fertilizer use is that small farmers have a larger proportion of land under MVs (Table 32), which are much more fertilizer-intensive than traditional varieties of rice. To dissociate the cropping-pattern effect, the adoption pattern for specific crop varieties has also been reviewed (Table 38). The inverse size effect prevails in the case of MVs for all three seasons and is highly pronounced in the case of MV boro. For local varieties on which fertilizers are used in small amounts, no systematic pattern of use across the farm-size scale is found. Owner-farmers tend to use more fertilizer on local varieties than do tenants, but no systematic pattern is found for MVs.

Table 38—Use of chemical fertilizers, by farm size and tenancy, 1982

	All Crops		Amount Used in Major Crops				
	Farmers Using Fertilizers	Amount of Nutrients Used	Modern Variety			Local	
Farm Group			Boro	Aus	Aman	Aus	Aman
	(percent)	(kilograms/ acre)	(kilograms/acre)				
Farm size[a]							
Small	85.5	24.4	68	47	38	9	8
Medium	92.3	21.9	64	47	39	7	8
Large	95.0	18.1	51	46	30	13	6
Tenurial status							
Owner	87.8	22.2	63	47	36	10	11
Tenant	90.8	21.6	65	46	38	7	4
All farms	89.2	21.9	64	47	37	9	8

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

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[83] For a summary of the findings of previous studies in this regard, see Herdt and Garcia, "Adoption of Modern Rice Technology;" and Hossain, "Fertilizer Consumption," pp. 197-206.

Adoption Behavior: An Econometric Analysis

The size and tenurial status of a farm are often surrogates for other factors that affect the adoption behavior of farmers. To explain the observed pattern of adoption reported in the previous sections, it is thus necessary to do a multivariate analysis of the factors that determine the adoption behavior and the importance of these factors for different groups of farmers. This is attempted here through the use of the multivariate regression technique. First, a probit model is used to identify the factors that affect the decision to adopt MV rice, and then a tobit model is used to explain the extent of adoption.

The following model was estimated by using the probit method to identify factors that affect the farmers' decision on whether to adopt MVs or not:

$$ADPT = f(OWNL, TNC, IRGP, CRDTI, CRDTN, LBR, LNDPC, NAGRI, INFR), \quad (10)$$

where

ADPT = dichotomous adoption variable that takes value 1 for adopter farms and zero for nonadopter farms,

OWNL = amount of land owned by household (in acres),

TNC = proportion of land rented,

IRGP = proportion of land irrigated,

CRDTI = amount of loans received from institutional sources (in Tk 100/acre),

CRDTN = amount of loans received from noninstitutional sources (in Tk 100/acre),

LBR = amount of land cultivated per worker (in acres),

LNDPC = amount of land owned per member in household (in acres),

NAGRI = income from trade and industry per acre of cropped land (in Tk 100/acre),

INFR = index of underdevelopment of infrastructure at the village level.[84]

LBR and LNDPC are measures of labor scarcity and subsistence pressure in the household and are expected to negatively influence the decision to adopt MVs. CRDTI,

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[84] This is a composite index of infrastructure underdevelopment constructed by Ahmed and Hossain from the village-specific information on access to a number of elements, such as roads, markets, and financial and educational institutions, for a separate study of the effect of infrastructure on rural development. The infrastructure variable significantly affects a number of endogenous variables investigated in the present study, but the results have not been reported here in order not to preempt the findings of the other study. The conclusions of this study remain valid even after inclusion of the infrastructure variable. See Raisuddin Ahmed and Mahabub Hossain, "Infrastructure and Development of a Rural Economy," International Food Policy Research Institute, Washington, D.C., 1987 (mimeographed).

CRDTN, and NAGRI are expected to ease the capital constraint and hence should have a positive influence on adoption decision.

The results of the exercise are presented in Table 39. Estimated equation 1 in the table incorporated only the farm-size and tenancy variables, and they are found statistically insignificant with an extremely low $\bar{R}^2$ for the regression equation (obtained in the OLS estimate of the parameters). The labor-scarcity and subsistence-pressure variables have right signs of the estimated parameters but they are also statistically insignificant. An alternative labor-scarcity variable was measured by the proportion of hired labor (LBRH), but the negative value of the coefficient is also statistically insignificant (equation 3 in the table). Institutional-credit and nonfarm-income variables, in fact, have opposite signs but are not statistically significant. Only irrigation and development of infrastructure are significantly positively associated with the adoption of MVs. When the effects of the other variables are controlled, the proportion of area under tenancy is significantly positively correlated with the adoption variable.

A large number of variables and their measurements were experimented with to select the variables that best explain the extent of adoption of MVs. After careful scrutiny of the results of alternative estimates, the following model is found to best explain the variation of MV adoption in the sample:

Table 39—Factors influencing decision to adopt modern varieties, probit estimate

Variable	Equation 1	Equation 2	Equation 3
Constant	0.452 (4.89)	−0.105 (−0.46)	−0.038 (−0.16)
OWNL	−0.016 (−0.98)	0.015 (0.56)	0.012 (0.47)
TNC	0.802 (0.42)	0.914^a (3.70)	0.871^a (3.54)
IRGP	. . .	4.171^a (10.57)	4.164^a (10.62)
CRDTI	. . .	−0.371 (−0.25)	−0.056 (−0.04)
CRDTN	. . .	0.324 (0.75)	0.316 (0.73)
LBR	. . .	−0.040 (−0.90)	. . .
LNDPC	. . .	−0.206 (−0.83)	−0.302 (−1.51)
NAGRI	. . .	−0.098 (−0.64)	−0.087 (−0.56)
INFR	. . .	−0.047^b (−2.08)	−0.047^b (−2.08)
LBRH	. . .	. . .	−0.239 (−0.82)
$\bar{R}^2$	0.01	0.33	0.33

Notes: The sample consists of 470 farm households. Figures in parentheses are asymptotic t-values. Values of $\bar{R}^2$ are for OLS estimates.

[a] This number is significant at the 0.01 level.

[b] This number is significant at the 0.05 level.

MVP = f(IRGP, LBR, FSZ, CRDTI, CRDTN, NAGRI, EDNH, OWNL, TNC), (11)

where

MVP = proportion of cultivated area under MVs,

FSZ = number of members in family, which is a measure of consumption pressure in the household, and

EDNH = level of education of head of household (completed years of formal schooling).

Other variables are as explained earlier.

The equation was estimated separately for two seasons. For the overlapping aus and boro seasons, irrigation is a prerequisite for adoption of MVs because the rainfall is scanty and paddling of soil for transplantation of seedlings cannot be done without irrigation. This is also a relatively slack season for agricultural activity, since a significant proportion of land remains fallow. So factors like labor shortage may not be binding constraints for adoption during this season. During the aman season, rainfall is plentiful, so MVs can be grown under rain-fed conditions. But a physical control is imposed by land elevation, since low land remains deeply flooded throughout the season and is thus unsuitable for growing MVs. Since most of the land is cropped during this season, occasional labor shortages may appear. Owing to these differences, the analysis at the seasonal level was thought to be more appropriate. The proportion of medium-high land was used as another explanatory variable, but the coefficient was not found to be statistically significant and, in fact, had a negative sign in the equation for aus and boro seasons. Since irrigation was highly correlated with this variable, the land-elevation variable was dropped in the final estimated equation to avoid the problem of high multicollinearity.

Care must be taken in selecting the method of estimating the parameters of the specified model, since the observed value of the dependent variable has a limited range. This is the case of a limited dependent variable model, and the application of the least square method to the observed data may lead to seriously biased estimates. Since the dependent variable is observed in the range of zero to one, that is, it is censored in both tails, the "two-limit probit" (tobit) model appears to be the most appropriate technique for its estimation. The software LIMDEP developed by Greene[85] for estimation of the tobit model was applied to the data set to get the values of the parameters of the model.

The estimated parameters are reported in Table 40. As expected, irrigation is found to be the most significant variable in determining the adoption rate. The asymptotic t-value for the estimated coefficient is the highest for irrigation compared with all other variables included in the model. Dropping this variable from the equation reduces the value of the adjusted coefficient of determination ($\bar{R}^2$) from 0.47 to 0.08. The comparison of the t-value for this coefficient for the two seasons indicates that for adoption of MVs, irrigation is more important for the boro and aus seasons than for the aman season.

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[85] William H. Greene, *LIMDEP: User's Manual,* May 1986; William H. Greene, "On the Asymptotic Bias of the Ordinary Least Squares Estimator of the Tobit Model," *Econometrica* 49 (No. 2, 1981): 505-513; and G.S. Maddala, *Limited Dependent and Qualitative Variables in Econometrics* (Cambridge: Cambridge University Press, 1984).

Table 40—Determinants of adoption of modern varieties of rice, 1982

	Boro and Aus Seasons		Aman Season		All Seasons	
Variable	OLS Estimate	Tobit Estimate	OLS Estimate	Tobit Estimate	OLS Estimate	Tobit Estimate
OWNL	−0.291 (−0.65)	−0.484 (−0.99)	0.036 (0.08)	0.002 (0.004)	−0.255 (−0.41)	−0.429 (−0.74)
TNC	0.130[a] (2.74)	0.137[a] (2.99)	0.183[a] (4.00)	0.190[a] (3.73)	0.314[a] (4.70)	0.283[a] (4.64)
IRGP	0.609[a] (14.09)	0.651[a] (11.10)	0.527[a] (12.57)	0.547[a] (10.02)	1.137[a] (18.69)	1.084[a] (12.56)
LBR	−1.305 (−0.95)	−1.639 (−0.88)	0.733 (0.55)	0.581 (0.45)	−0.572 (−0.30)	−0.550 (0.25)
FSZ	0.539 (0.92)	0.743 (1.07)	0.311 (0.55)	0.264 (0.43)	0.850 (1.04)	0.337 (0.38)
EDNH	−0.403 (−1.02)	−0.396 (−0.80)	−0.248 (−0.65)	−0.269 (−0.65)	−0.650 (−1.169)	−0.416 (−0.66)
CRDTI	0.351[b] (1.71)	0.518[c] (2.36)	0.442[c] (2.21)	0.459[c] (2.48)	0.793[a] (2.74)	0.743[a] (2.74)
CRDTN	0.423[a] (4.64)	0.625[a] (5.07)	−0.108 (−1.23)	−0.113 (−0.87)	0.315[a] (2.46)	0.695[a] (3.82)
NAGRI	0.137 (−1.44)	−0.165 (1.46)	−0.126 (−1.368)	−0.134 (−1.10)	−0.264[c] (−1.97)	−0.290[c] (−1.99)
(Constant)	0.14[a] (3.36)	0.14[c] (2.38)	−0.004 (−0.10)	−0.004 (0.06)	0.14[c] (2.33)	0.17[c] (2.34)
(σ)	. . .	33.141[a] (24.58)	. . .	30.19[a] (25.88)	. . .	40.0[a] (19.67)
$\bar{R}^2$	0.36	. . .	0.28	. . .	0.48	. . .
Log-L	. . .	−2,037	. . .	−2,136	. . .	−1,768

Notes: The sample consists of 470 farm households. Figures in parentheses are asymptotic t-values.
[a] This number is significant at the 0.01 level.
[b] This number is significant at the 0.10 level.
[c] This number is significant at the 0.05 level.

The value of the coefficient (in the equation for all seasons) indicates that a 10 percent increase in the area under irrigation may increase the proportion of land under rice MVs by about 11 percent.

The coefficient of the family-worker variable is positive for the aman season, indicating that—given the amount of land to be cultivated—the higher the availability of family labor, the greater the tendency to cultivate MVs. The value of the coefficient, however, is not found to be statistically significant. For the aus and boro seasons, the coefficient of this variable has an opposite sign, but it is not statistically significant. As indicated earlier, this is the slack season for agricultural activity, so households with a lower endowment of labor relative to land may not be constrained in growing more labor-intensive crops, as they can count on easy availability of hired labor.

The coefficient of family size is positive for both seasons, thus supporting the Chayanovian hypothesis that the higher the subsistence pressure, the greater the tendency to adopt the new technology. The relationship, however, is weak. The value of the coefficient is not statistically significant.

In the context of a small-farmer peasant economy as in Bangladesh, the shortage of working capital is often emphasized as a major constraint to adoption of the new technology. In this exercise, the amount of loans received per unit of land has been taken as a proxy of the availability of liquid funds, which may ease the capital constraint. The variable, however, could not be measured as season-specific, so it is difficult to interpret the value of the coefficient of this variable in the equations for different seasons. The value of the coefficient of institutional credit is positive for both seasons, which suggests that the availability of institutional credit facilitates adoption. The coefficient is found to be statistically significant in all the equations at less than 5 percent probability of error. This result may seem surprising, since the access of small farmers to agricultural-credit institutions is still limited, although the supply of agricultural credit from institutional sources increased about eight times (at real value) during 1975-84. During 1983/84, the amount disbursed was about 7 percent of the value added in agriculture and 2.3 times the cost of fertilizer consumed in the country.[86] The credit is concentrated in the hands of the medium and large farmers. In the present sample, only 13 percent of the farm households received institutional loans during 1982, and the amount of institutional loans was about a quarter of the total loans received by them.

The incidence of borrowing from noninstitutional sources was found to be widespread. Nearly two-thirds of the farmers borrowed from friends and relatives—most often without any interest—and also from local moneylenders, who charge very high rates of interest. Nearly 40 percent of the loans from noninstitutional sources were free of interest. The coefficient of the noninstitutional credit variable is found to be positive and statistically significant at less than 5 percent probability of error for the aus and boro seasons. For the aman season, however, the coefficient has an opposite sign, but it is not statistically significant. Because of the need for irrigation and more-intensive use of fertilizer, the working capital requirement for the cultivation of MV crops is significantly higher for the boro and aus seasons than for the aman season (Chapter 4). The proportion of holdings allocated to MVs is also less for the aman season. Thus farmers who do not have access to formal credit institutions may tap noninstitutional loans to cultivate MVs during the dry season, while their own resources may be sufficient for cultivating the small amount of land that they currently allocate to MVs during the aman season.

Farmers who earn some income from nonagricultural sources may have less liquidity constraint than those who depend mostly on agriculture, so access to nonagricultural income may ease the capital constraint to adoption of MVs. The amount of income earned from trade and industry per unit of cultivated land was related to the intensity of adoption in order to test this hypothesis. The value of the coefficient is found to be negative irrespective of the season, which is contrary to the hypothesis. The negative value is statistically significant for all seasons. In fact, it is found in further tests that if the service incomes are added, the t-value for the negative coefficient increases. This indicates that farmers who cannot adopt MVs because of technical constraints (such as nonavailability of irrigation) try to augment household incomes in alternative ways; for example, by self-employment in various nonagricultural activities and by taking temporary low-income employment (such as public works programs). (See Chapter 7 for further details.)

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[86] The supply of agricultural credit from institutional sources increased about eight times (at real value) during 1975-84. During 1983/84, the amount disbursed was about 7 percent of the value added in agriculture, and 2.3 times the cost of fertilizers consumed in the country. See Mahabub Hossain, "Institutional Credit for Rural Development: An Overview of the Bangladesh Case," *The Bangladesh Journal of Agricultural Economics* 8 (No. 1, 1985): 1-16.

Another variable for which the result is found to be contrary to the a priori hypothesis is the level of education. The value of the coefficient is found to be consistently negative in all equations, thus indicating that the less educated adopt MVs more intensively. This finding tends to support the contention that the type of education provided in schools is not agriculture oriented. Education provides better opportunities for nonagricultural employment, which may be higher paying and less arduous than agricultural employment. Thus, although education gives better access to information about the new technology, it may not necessarily facilitate adoption of the technology.

When the effects of other socioeconomic variables are controlled, the size of landownership does not seem to affect the intensity of adoption. The coefficient of the landownership variable is positive for the aman and negative for the boro season, but the values are not statistically significant. The estimated t-value is less than one for all cases. The tenancy variable, however, still remains highly statistically significant. The positive value of the coefficient indicates that the extent of adoption of MVs is higher on rented land than on owned land. Since MVs are labor-intensive, and tenants rent land to minimize underutilization of family workers, the large landowners may gain more by having sharecroppers cultivate MVs than by self-cultivating them with wage laborers. Since there is so much excess demand for land, the tenancy market may be governed more by the interests of the landowners than by those of the tenants, who would be discouraged by the crop-sharing arrangements from cultivating MVs on rented land.

The higher intensity of adoption on smaller farms, as reported in the previous section, comes mainly through availability of irrigation and incidence of tenancy. Irrigation in Bangladesh is mostly exogenously determined. It is developed by the government, often with foreign assistance. Irrigation has spread mostly in areas where the average farm size is low (the eastern and southeastern parts of the country). In the coastal and flood-prone districts where there are physical constraints to development of irrigation, concentration of land in the hands of large farmers is generally higher. So the proportion of irrigated land is found to be higher on small farms (see Table 41).

Table 41—Incidence of irrigation and tenancy for different groups of farmers

Farm Group	Share of Land Irrigated: Sample Farmers, 1982[a]	Share of Land Irrigated: Bangladesh Agricultural Census, 1983-84[b]	Share of Cropped Area Under Tenancy of Sample Farmers, 1982
		(percent)	
Farm size			
Small	32.3	22.8	37.9
Medium	32.9	19.0	9.9
Large	28.3	18.3	4.0
Tenurial group			
Owner	33.6	n.a.	0.0
Tenant	29.6	n.a.	35.4
All farms	31.7	19.9	15.9

Sources: Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84* (Dhaka: Ministry of Planning, 1986); and data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: n.a. means not available.

[a] As a percentage of owned land.

[b] As a percentage of cultivated holding. Medium farms are defined in the census as those with 2.5-7.5 acres of operated area.

The same pattern is noted for the country as a whole in the latest agricultural census (1983-84).[87] Tenancy cultivation is also more prevalent among the smaller farmers. It was found in the present survey that about one-sixth of the cropped land was tenant cultivated; the proportion was 38 percent for small farms, compared with only 4 percent for large ones.

Size, Land Productivity, and Prices

The observation that adoption of the new technology is inversely related to farm size does not necessarily imply that in Bangladesh the income distribution effect associated with diffusion of the new technology would be favorable to the smaller farmers. The impact on income distribution would also depend on the variation in productivity and prices among different groups of farmers.

For Bangladesh, many studies show an inverse relationship between farm size and land productivity.[88] Most of the findings are, however, for areas that did not experience significant diffusion of the new technology and refer to time periods (mostly the late 1960s and early 1970s) when the technology was in early stages of adoption. Some of the studies for India,[89] where the size-productivity relationship is also found to be inverse in the case of the traditional crops,[90] argue that this relationship may not hold for the new technology, as it gives considerable scope for using capital. Since the larger farmers have more accumulated savings and also have better access to financial markets, they are in a better position to apply purchased inputs like fertilizer and water more intensively than the smaller farmers. Thus a positive size effect on the yield rates for MVs may be expected, depending on the importance of the new inputs in cultivation of the variety.

The differences in land productivity among the size groups of farms observed in the survey may be reviewed in Table 42. Since the productivity may also vary, depending on the stage of development of the new technology, the sample villages have been classified into two equal groups according to the proportion of area under MVs. The developed villages have about 60 percent higher rice yields than the underdeveloped villages. In the cultivation of MVs the yield is about 14 percent lower in the developed villages, which may be due to diffusion of MVs to marginal farmers and marginal land, as well as to production of two rice crops per year on some land, which reduces the yield of each crop. In the cultivation of local varieties the yield is about 20 percent higher for the developed villages.

The yield is found to be inversely related to farm size in both groups of villages and for both the traditional and modern varieties of rice. The difference in yield between

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[87] Bangladesh, *Census of Agriculture and Livestock.*

[88] See, among others, Mahabub Hossain, "Farm Size, Tenancy, and Land Productivity: An Analysis of Farm Level Data in Bangladesh Agriculture," *The Bangladesh Development Studies* 5 (No. 3, 1977): 285-348; and M. A. Sattar Mandal, "Farm Size, Tenancy and Productivity in an Area of Bangladesh," *The Bangladesh Journal of Agricultural Economics* 3 (December 1980): 21-42.

[89] Prannoy Roy, "Transition in Agriculture: Empirical Indicators and Results," *Journal of Peasant Studies* 8 (No. 2, 1981): 212-241; and G. S. Bhalla and G. K. Chadha, *Green Revolution and the Small Peasant* (New Delhi: Concept, 1983).

[90] Krishna Bharadwaj, *Production Conditions in Indian Agriculture,* Department of Applied Economics Occasional Paper 33 (Cambridge: Cambridge Unversity Press, 1974); Biplob Dasgupta, *The New Agrarian Technology and India* (New Delhi: Macmillan, 1977); and Pranab K. Bardhan, "Size, Productivity, and Returns to Scale: An Analysis of Farm-Level Data in Indian Agriculture," *Journal of Political Economy* 81 (No. 6, 1973): 1370-1386.

Table 42—Farm size and land productivity, by technology, 1982

Farm Size[a]	Technologically Developed Villages			Technologically Underdeveloped Villages		
	Local Varieties	Modern Varieties	All Rice Varieties	Local Varieties	Modern Varieties	All Rice Varieties
	(metric tons/acre)					
Small	0.72 (0.08)	1.29 (0.13)	1.10 (0.11)	0.63 (0.09)	1.53 (0.38)	0.73 (0.10)
Medium	0.71 (0.09)	1.13 (0.13)	0.93 (0.08)	0.53 (0.07)	1.37 (0.41)	0.58 (0.09)
Large	0.61 (0.14)	1.09 (0.24)	0.86 (0.20)	0.51 (0.12)	1.06 (0.77)	0.57 (0.13)
All farms	0.71 (0.06)	1.23 (0.09)	1.03 (0.08)	0.58 (0.06)	1.43 (0.26)	0.64 (0.07)

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: Figures in parentheses are standard errors of estimate.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

the small and large farmer is, however, less pronounced for the technologically developed villages than for the underdeveloped ones, suggesting that with diffusion of the technology, the productivity gap narrows to some extent. Still, in the developed villages, the productivity for small farmers is about one-fifth higher than for large farmers, and the difference is statistically significant.

The income from cultivation may also differ across farms due to variation in prices. The new technology has increased the dependence of the farmers on the market for acquisition of the new inputs and also for labor. The prices of the inputs may vary across farms, especially under conditions of underdeveloped infrastructure facilities and monopoly control on the supply of the new inputs. The prices paid by different groups of farmers for the major agricultural inputs can be reviewed in Table 43. The fertilizer prices are reported separately for the dry and monsoon seasons because the prices, which are government controlled, were raised on July 1, 1982, so farmers

Table 43—Prices of major agricultural inputs, by farm size and tenancy, 1982

Farm Group	Fertilizer Price		Irrigation Charge in Boro Season	Wage Rate
	Boro and Aus Seasons	Aman Season		
	(Tk/kilogram)		(Tk/acre)	(Tk/day)
Farm size[a]				
Small	3.20	3.64	672	20.22
Medium	3.23	3.55	583	19.43
Large	3.18	3.51	544	17.73
Tenurial status				
Owner	3.20	3.58	589	18.91
Tenant	3.22	3.62	698	22.88
Total	3.21	3.60	627	19.59

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

growing aman crops faced higher prices than those growing boro and aus crops, and the effect of this factor needs to be dissociated.

The fertilizer prices seem to be invariant with the size and tenurial status of the farm, but the water charge and the wage rate vary considerably across farms. The small farmers paid about 24 percent higher prices for water than the large farmers. Tenant farmers paid about 19 percent higher water charges than did owner farmers. This is expected because the ownership and management of irrigation equipment is controlled more by the large landowners. The government started selling deep tubewells and low-lift pumps to individuals and cooperatives in 1979/80. By the end of 1983, some 43 percent of the operating deep tubewells and 56 percent of the low-lift pumps were owned by the private sector. Nearly two-thirds of such machines were owned by households with 5 acres of land or more.[91] The small farmers and tenants also paid substantially higher wage rates than the large landowners. Since the tenants and small farmers come to the labor market during busy periods, when the wage rates are higher, the weighted average wage rate is expected to be higher for them, although for a particular day all farmers may face the same wage rate.

The cost of working capital may also be higher for small farmers because they have to borrow more from the high-cost, noninstitutional sources. This survey found that nearly three-fourths of the small farmers took loans from noninstitutional sources, compared with two-fifths among the large farmers. The institutional sources accounted for 20 percent of the total loans taken by small farmers, compared with 44 percent for the large farmers.

Conclusions

In Bangladesh, small farmers and tenants have adopted the modern technology at least as much as have large farmers and owner-cultivators. The scale neutrality of adoption may have been the result of the government investment for development of irrigation, which is the main vehicle for diffusion of the modern technology. Even under private investment on tubewells and power pumps, small farmers have as much access to irrigation facilities as the large ones because of the randomness with which the extremely fragmented and scattered farm holdings are distributed.

The small farmers, however, pay higher prices for inputs, particularly for water, labor, and working-capital loans. The ownership of privately owned machines and the management of the irrigation cooperatives is controlled by large farmers, who take a sizable markup from the irrigation market. The small farmers paid a water charge about 25 percent higher than the large farmers, and a 10 percent higher wage rate, presumably because the small farmers have to go to the labor market during busier periods of agricultural operations. Since the small farmers have to borrow more from the high-cost informal markets than do the large farmers, the average cost of working capital may also be higher for the small farmers. The variation in the prices of agricultural inputs would thus put a negative pressure on income distribution, which might outweigh the effect of the inverse relationship between farm size and adoption rates.

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[91] M. Abul Quasem, "Impact of the New System of Distribution of Irrigation Machines in Bangladesh," *The Bangladesh Development Studies* 13 (September-December 1985): 127-140.

7

LABOR MARKET AND EMPLOYMENT EFFECTS OF MODERN TECHNOLOGY

In Bangladesh, nearly a third of rural households do not own any cultivable land, and about a half own less than 0.5 acre; for them, farming is only a marginal source of income.[92] Having no access to land, most of these households are at the bottom of the rural income scale. Their income depends on conditions in the labor market, that is, duration of employment and wage rate. The new technology would affect the agricultural-labor market by changing the labor intensity of cultivation, the productivity of labor, which in turn would influence the wage rate, and the income of the farmer, which would affect his labor/leisure choice. The technology could also indirectly affect the nonagricultural labor market, since the expenditure of the increased agricultural income would generate additional demand for nonagricultural goods and services, some of which might be produced within the locality.[93] The objective of this chapter is to trace these employment effects of the new technology. Although the main focus is on employment generation for the landless and the marginal farmers, employment for the land-owning groups has also been studied, since their self-employment behavior would affect the labor market.

Employment in rural Bangladesh consists mainly of self-employment, and most of the agricultural workers are hired on a daily basis. Workers change jobs from one day to another, from self-employment to wage employment and from agriculture to other forms of employment. Under these circumstances, accurate information on employment can be obtained only through a large number of regular surveys covering a short period, so that respondents can recall what they did during this period. To collect accurate information for the whole year, it would be better to conduct 52 weekly surveys, but that would have been extremely expensive and taxing for the respondents. Considering the trade-offs, this survey collected information for all members of the sample households who participated in productive work for each day of the week preceding the day of interview, for eight weeks scattered throughout 1982. The periods were selected on the basis of a priori knowledge of the cropping pattern of the area so as to represent the normal, busy, and slack periods of employment. The supply of labor for the whole year and the composition of employment has been estimated by extrapolating the data for the eight weeks. The demand for agricultural labor has been estimated from labor use in crops, as reported by farmers in three rounds of interviews conducted at the end of each crop season during 1982.

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[92] According to the land occupancy survey of 1978, the first attempt in the country to get information on landownership, 15 percent of rural households did not own any land, and 29 percent owned only homestead land. But households that claimed no more than 0.5 acre of land other than the homestead, and are considered in Bangladesh as "functionally landless," constituted 50 percent of rural households in that year. In 1983/84, according to the latest agricultural census, 9 percent of the households did not own any land and 46 percent owned less than 0.5 acre. About 40 percent of the households reported agricultural wage labor as their main occupation; two-thirds of them owned less than 0.5 acre. See Jannuzi and Peach, *Agrarian Structure of Bangladesh,* p. 110; and Bangladesh, *Census of Agriculture and Livestock,* pp. 81, 267.

[93] John W. Mellor, *The New Economics of Growth: A Strategy for India and the Developing World* (Ithaca: Cornell University Press, 1976). For detailed empirical investigations see, among others, Peter B. R. Hazell and Ailsa Roëll, *Rural Growth Linkages: Household Expenditure Patterns in Malaysia and Nigeria,* Research Report 41 (Washington, D.C.: International Food Policy Research Institute, 1983); and Mahabub Hossain, "Agricultural Growth Linkages: The Bangladesh Case," *The Bangladesh Development Studies* 15 (No 1, 1987).

Participation in Economic Activities

A worker has been defined as a person who was available for work in income-earning or expenditure-saving activities (henceforth called economic activities) during any of the eight weeks of the survey. These activities included supervision of farm labor, crop cultivation, postharvest processing and marketing, livestock and poultry raising, commercial and subsistence fishing, vegetable growing in kitchen gardens, cottage industries, house construction and repair, earthwork, collection of fuel, and trade, transport, and other services. Domestic labor for women should also be regarded as expenditure saving for the household, but it was not considered in this definition. The average number of workers, thus defined, is 1.88 persons per household out of a household size of 6.34 persons for the entire sample. Thus the labor force participation rate (workers divided by members) is 29.7 percent of the rural population, which is very close to the 29.4 percent activity rate reported in the national labor force survey of 1983-84.[94] The low rate of participation in economic activities is partly because of the large proportion of the young population (up to age 15), but is mainly due to the virtual absence of women from the country's labor force. About 35 percent of the population in the sample was below age 10, and only 8 percent of the female population participated in economic activities. The rate of participation of women in income-earning activities is estimated at 5.1 percent by the 1981 population census and 7.9 percent by the 1983-84 labor force survey.

The labor force participation rates for different landholding groups can be reviewed in Table 44. The impact of the new technology is assessed by comparing the information

Table 44—Labor force participation in developed and underdeveloped areas, by landholding, 1982

Landownership Group[a]	Average Number of Persons in Family	Average Number of Workers (Age 15 and Over) in Family	Participation Rate	Male Workers as Proportion of Family Members	Female Workers as Proportion of Family Members
			(percent)	(percent)	(percent)
Underdeveloped villages	6.19	1.84	29.7	27.3	7.9
Landless	4.82	1.55	32.2	28.8	10.4
Small	5.98	1.82	30.4	27.7	8.9
Medium	7.04	2.09	29.7	28.4	4.2
Large	8.87	2.21	24.9	22.9	8.0
Developed villages	6.52	1.93	29.6	25.8	12.8
Landless	5.45	1.88	34.5	27.3	21.0
Small	5.93	1.70	28.7	24.6	13.9
Medium	7.38	2.08	28.2	26.0	8.1
Large	9.08	2.52	27.8	26.6	3.9

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

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[94] The crude activ[illegible]ate is estimated at 30.0 percent for the country as a whole, 34.2 percent for urban areas, and 29.4 percer[illegible]ural areas. See Bangladesh, *Final Report: Labour Force Survey, 1983-84*, p. 25.

for two groups of villages, equally divided according to the scale of the adoption rate of the new technology (see Chapter 2). The average number of persons in the household was about 5 percent higher in the developed villages, and the difference is statistically significant. This difference is, however, mainly due to the landless category. The difference for other groups is not significant. Presumably, better economic conditions in developed villages reduce mortality rates and increase family size for the landless category.

The participation rate is similar in the two groups of villages. The participation of women is, however, marginally higher in the technologically developed villages and is significantly higher for the landless and small farmer groups. The proportion of female workers in landless households is about 21 percent in the developed villages, compared with 10 percent in the underdeveloped villages. This difference may be due to more employment opportunities being generated for women in nonagricultural activities in the developed villages. The number of male workers as a proportion of the total population is about 25.8 percent in the developed villages, compared with 27.3 percent in the underdeveloped villages.

Size of landholding has a strong influence on the participation rate. In the underdeveloped villages, the participation rate is about 32 percent for the landless and marginal landowners compared to 25 percent for the large landowners. Similar differences are found in the developed villages. The female participation rate is also higher among the landless and the marginal landowners, significantly so in the developed areas. With technological advancement, the participation of males in the labor force appears to decline.

The participation rate can be taken as a proxy indicator of the supply of labor in the stock sense. The findings that technological advancement and size of landownership have a negative influence on the participation rate indicate that leisure is substituted for labor at higher levels of income. It appears that the very poor households supply as many workers as possible to the labor force in order to earn a subsistence income for the family, subject to job availability and limitations imposed by socioreligious factors.[95] As income increases with technological progress or a larger amount of land, or both, a household may withdraw the women and children from the labor force in order to have higher social status and better education for the children.

The above point is further demonstrated in Table 45, which shows occupations of family members aged 10 to 25—the age group that participates in the labor force, attends educational institutions, or takes up domestic duties as housewives. The labor force participation rate in this age group is about 27 percent in the developed villages, compared with 37 percent in the underdeveloped villages. Although a larger proportion of the female population in this age group is married and takes up domestic work, the main reason behind the lower participation rate in developed villages is greater participation in educational institutions. The proportion of students in this age group is 36

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[95] In Bangladesh there is a social stigma against women working in the field or performing manual labor for others. The women from very poor families, however, try to earn or to save expenditures by organizing production around the homestead. About 75 percent of the people who took loans in 1986 from the Grameen Bank, an institution created for providing credit to landless households, were women. They took loans mostly for livestock and poultry raising, cottage industries, and shopkeeping activities. A large survey in 1979 found that nearly two-fifths of the workers employed in cottage industries were women and 84 percent of them were unpaid family laborers. As agricultural incomes increase, the demand for these activities in which the poor women can find employment may also go up. See Mahabub Hossain, *Credit for Alleviation of Rural Poverty: The Grameen Bank in Bangladesh*, Research Report 65 (Washington, D.C.: International Food Policy Research Institute, 1988); and Mahabub Hossain, "Employment and Labour in Bangladesh Rural Industries," *The Bangladesh Development Studies* 12 (March-June 1984): 1-24.

Table 45—Occupation of family members aged 10 to 25, by landownership and sex, 1982

Group	Underdeveloped Villages				Developed Villages			
	Students	Housewives	Inactive	Workers	Students	Housewives	Inactive	Workers
				(percent)				
Landownership[a]								
Marginal	16.4	39.7	9.3	34.6	23.0	37.2	7.5	32.2
Small	18.9	37.8	3.0	40.2	32.1	34.0	3.3	30.6
Medium	27.2	34.7	1.9	36.2	46.2	32.1	2.7	19.0
Large	50.0	24.0	6.0	20.0	57.5	21.3	4.3	17.0
Sex								
Male	29.9	. . .	3.6	66.5	49.6	. . .	7.1	43.3
Female	16.3	71.5	6.4	5.8	22.1	65.6	3.1	9.2
Total	23.1	36.4	4.9	35.7	36.0	32.9	4.7	26.5

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

percent in the developed villages, compared with 23 percent in the underdeveloped villages. A larger proportion of males than of females attends school. With technological progress, the student population increases for both sexes, but the increase is more pronounced for males—about 50 percent in the developed villages, compared with 30 percent in the underdeveloped villages. Size of landownership also significantly influences school attendance. In underdeveloped villages, students compose less than one-fifth of this age group in households owning less than 2.5 acres, but about one-half in households with 5.0 acres of land or more. Even after controlling for the effect of landownership group, school attendance is higher in developed villages.

Education increases the quality of labor and provides opportunity for taking higher-paid nonagricultural employment. Even self-employment in trade, services, and processing activities requires functional knowledge of reading, writing, and arithmetic. Considering the above, the downward pressure of technological advancement on labor force participation should be taken as a positive development. With improved economic conditions, the lower-income groups can afford to send more children to school and have better education, which may promote occupational mobility and increase lifetime earnings.

Extent and Composition of Employment

Since the average number of hours of work per day may vary across villages, and a worker may be engaged in a number of activities during a day, the information on duration of employment was collected in the survey in hours, by activity, for each of the workers in the sample households. The information was collected on a daily basis for seven days preceding the date of the interview and may contain some margin of error due to memory recall. The estimate of total employment at the household and worker levels has been built up from the data and is measured in average weekly employment hours for the eight weeks of the survey. The information can be converted to standard eight-hour days of employment for the year 1982. It may be mentioned here that the figures measure only the supply of labor by the sample households, both on own and others' account, which may not necessarily be equal to total employment generated in the study areas. The estimation of total employment would have required data on in- and out-migration of labor in flow terms, which were not collected by the survey.

The average duration of employment estimated from the survey is about 39 hours per week, or about 253 standard eight-hour days during the year of the survey. About 62 percent of the employment was generated in agricultural activities. Self-employment accounted for about 68 percent of the total employment. The respondent workers reported that they were available for work 345 days a year. On this basis the rate of underemployment is estimated at about 27 percent.[96] However, if six days of work a week is taken as a full-employment norm, then the rate of underemployment on the time criterion is estimated at only 19 percent.

The duration of employment for different landownership groups in the technologically developed and underdeveloped areas can be reviewed in Table 46. It appears from the data that the supply of labor declines with technological advancement. Compared with underdeveloped villages, the supply of labor in developed villages is about 13 percent lower at the worker level and 9 percent lower at the household level. The duration of employment is also inversely related to the size of landownership, reflecting that at higher levels of income, people substitute leisure for labor. The workers belonging to landless households worked, on average, for about 42.4 hours a week, compared with 38.2 hours for workers belonging to households owning 5 acres of land or more—a difference of about 11 percent. With technological advancement, the difference becomes more pronounced—the landless putting in about 24 percent more labor than the large landowners. The reduction in duration of employment is less for the landless than for the landowning groups. In fact, at the household level, the landless in developed villages supply about 14 percent more labor than their counterparts in underdeveloped villages. Thus, by raising incomes, technological progress puts a downward pressure on the supply of labor. As the higher-income groups demand more leisure, the increase in labor demand generated by the new technology is met by increased supply from the lower-income groups; some of it may even be supplied by migrant workers from villages where the technology has not yet developed. In that sense, the comparison of the duration of employment between developed and underdeveloped areas underestimates the positive employment effect of the new technology on the lower-income groups.

The substitution of leisure for labor at higher income levels is more pronounced for arduous agricultural activities. This is shown in Table 47. Labor supply in agriculture is positively related to the amount of land owned, because of greater opportunities for self-employment on larger farms. But with technological advancement, the workers who belong to farm households put in less labor in agriculture than do their counterparts in underdeveloped villages. In contrast, the workers in the landless group supply about 80 percent more labor in the developed villages than in the underdeveloped ones. The total supply of labor in agriculture is about 7 percent more in the developed villages.

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[96] In rural Bangladesh open unemployment is rare, because family members share the household work, but underemployment is considerable. Estimates of the rate of underemployment for the country as a whole are not available. Estimates from different microstudies for the recent period vary from 28 to 43 percent. A part of the difference is due to regional variations, as most of the studies cover only a few villages in different areas of the country, but a large part of the variation can also be attributed to differences in concepts and definitions, particularly regarding the full employment norm. See Atiq Rahman and Rizwanul Islam, "Labor Use in Rural Bangladesh: A Study with Micro-Level Data," International Labour Organisation, Asian Employment Programme, Bangkok, 1985 (mimeographed); Iqbal Ahmed, "Unemployment and Underemployment in Bangladesh Agriculture," *World Development* 6 (December 1978): 1281-1296: and Mahmud Khan, "Labor Absorption and Unemployment in Rural Bangladesh," *The Bangladesh Development Studies* 13 (September-December 1985): 67-88.

Table 46—Duration of employment in technologically developed and underdeveloped areas, by landownership group, 1982

Landownership Group[a]	Average Employment per Household			Average Employment per Worker		
	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference
	(hours/week)		(percent)	(hours/week)		(percent)
Landless	65.37	74.39	13.8	42.40	40.09	−5.5
Small	75.47	63.87	−15.4	42.36	37.26	−12.0
Medium	87.79	66.67	−24.1	41.34	32.53	−21.3
Large	83.87	80.83	−3.7	38.24	32.33	−15.5
Total	76.38	69.62	−8.8	41.59	36.12	−13.2

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

The poor cannot afford to remain unemployed. Since the landless do not get enough employment on the land, they tend to engage more in nonfarm rural activities. In underdeveloped villages, about 64 percent of the employment for landless households was generated in nonagricultural activities, compared with only 22 percent for the large landownership group (Tables 46 and 47). As agricultural income increases with technological advancement, more demand is generated for nonfarm goods and services, some of which may be produced in rural areas (see Chapter 8). This may increase demand for labor in nonagricultural activities. It appears from the data that the additional employment is taken up by households in underdeveloped villages and by large landowning groups in developed villages. The supply of labor in nonagricultural activities is about one-third lower in the developed villages. The rate of decline increases with size of landownership but only up to the medium-sized farm group. The supply of labor to nonagriculture from the large landowning group is, in fact, greater in the developed villages.

Table 47—Duration of employment in agricultural and nonagricultural activities, by technology and landownership group, 1982

Landownership Group[a]	Agriculture			Nonagriculture		
	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference
	(hours of labor/week/household)		(percent)	(hours of labor/week/household)		(percent)
Landless	23.61	42.43	79.7	41.76	31.96	−23.5
Small	42.16	41.03	−2.7	33.31	22.84	−31.4
Medium	60.66	53.24	−12.1	27.13	13.43	−50.5
Large	65.42	60.53	−7.5	18.45	20.30	−10.0
Total	43.54	46.67	7.2	32.84	22.95	−30.1

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

Employment in some of the nonfarm activities whose market is expanded by increased rural incomes may require investment in working capital and some basic skills, such as functional reading, writing, and arithmetic, that can be acquired in schools. The poor may be constrained in taking up nonagricultural employment opportunities by widespread illiteracy and lack of access to financial institutions. Thus they may engage more in farming and in those nonfarm activities that require more manual labor than physical or human capital. This may often be distress employment, that is, very low productivity jobs taken by a worker when he has nothing else to do. As technological progress generates opportunities for additional employment in farming and increases the productivity of agricultural labor, employment in nonfarm activities is replaced by employment in agriculture.

Table 48 gives a detailed breakdown of employment by activity for all workers in the sample. The complete lack of specialization in rural employment is striking. Even farming does not generate enough employment for a household to keep one worker busy throughout the year. Rice farming poses the additional problem of the seasonal pattern of demand for labor, so even in large landowning households, family workers may remain unemployed during slack seasons of the year. A household may be engaged simultaneously in a number of agricultural and nonagricultural activities, and a worker may be engaged in a number of activities during the same week. It will be noted from the table that although 95 percent of the households participate in agricultural work, more than 90 percent also have some nonagricultural occupations. Nearly half of the households in the underdeveloped villages report miscellaneous nonagricultural activities (such as fencing and collection of fuel), which generate less than six hours of employment on average in a week for the households participating in such activities.

The activities for which the duration of employment declines with technological advancement are agricultural wage labor, cottage industry, trade and shopkeeping, earthwork, and miscellaneous jobs. Agricultural labor and earthwork are arduous and

Table 48—Labor supply in different activities in developed and underdeveloped areas, for all rural households, 1982

			Average Weekly Employment			
	Share of Households Engaged in the Activity		**Households Engaged in the Activity**		**All Households**	
Activity	**Underdeveloped Villages**	**Developed Villages**	**Underdeveloped Villages**	**Developed Villages**	**Underdeveloped Villages**	**Developed**
	(percent)		(hours)			
Agriculture	93.7	95.9	46.46	49.15	43.53	47.13
Cultivating family farms	81.1	80.3	34.34	34.64	27.85	27.82
Wage labor	45.3	40.1	23.54	22.98	10.66	9.21
Livestock and poultry raising	41.2	53.2	8.25	9.73	3.40	5.18
Fishing	18.6	26.4	8.76	18.60	1.63	4.91
Nonagriculture	92.5	90.5	35.52	25.62	32.86	23.19
Cottage industry	12.3	7.3	27.14	8.83	3.34	0.65
Trade and shopkeeping	31.1	26.1	24.74	21.31	7.70	5.56
Construction and transport	41.2	38.2	20.09	15.80	8.28	6.04
Services	21.7	38.9	26.40	19.20	5.73	7.46
Earthwork	27.4	14.0	14.48	13.61	3.97	1.91
Other	56.0	43.6	6.87	3.56	3.85	1.55

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

are also considered socially degrading if the work is performed for others. With increases in income, some households can afford to avoid this type of work. Miscellaneous activities may be performed when there is nothing else to do, so with increased employment opportunities, these are replaced by other work. The decline in labor supply to industry and trade, however, is surprising. Presumably, with increases in income, people tend to replace some low-quality products of cottage industries (often called dying industries) with competing products of formal industries, located mostly in urban areas. Also, labor productivity in many cottage industries and in petty trade is very low—even lower than the agricultural wage rate.[97] So when people do not find any work, they engage in these activities as self-employed workers. As the demand for, and the productivity of, agricultural labor increases with technological progress, these activities may be relocated to the underdeveloped villages where they may increase employment opportunities for the lower-income groups. Further investigation is necessary to test this hypothesis.

Labor Market

General Conditions

The size of the labor market is found to be quite small. Only about 32 percent of the labor hours were supplied against wages—22 percent in the agricultural sector and 49 percent in the nonagricultural sector (see Table 49). This is not surprising, since the typical holding in agriculture is too small to provide full employment for family workers, and many agricultural workers generate nonfarm employment on their own account in response to the lack of employment in the crop-production sector.

Table 49—Size of labor market from the supply side, by sector, 1982

	Share of Households Supplying Labor in the Market			Wage Labor as a Share of Total Labor		
Sector	Underdeveloped Villages	Developed Villages	Both Groups	Underdeveloped Villages	Developed Villages	Both Groups
	(percent)					
Agricultural	49.9	40.1	43.0	25.0	19.9	22.3
Nonagricultural	56.3	50.0	53.2	48.2	49.1	48.6
Total	67.9	63.4	65.7	35.0	29.5	32.3

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

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[97] On estimates of productivity of labor in cottage industries and petty trade, see Mahabub Hossain, "Productivity and Profitability of Bangladesh Rural Industries," *The Bangladesh Development Studies* 12 (March-June 1984): 127-161; and Mahabub Hossain, *Credit for the Rural Poor: The Grameen Bank in Bangladesh,* Research Monograph 4 (Dhaka: Bangladesh Institute of Development Studies, 1984), pp. 77-94. The former study found that if the cost of family labor is imputed by the agricultural wage rate, the profit becomes negative for a large number of cottage industries, such as net and rope making, cane and bamboo works, mat making, and rice processing by indigenous methods, which account for about one-third of cottage industry employment. These activities are undertaken to raise household income through employment of female labor and of male labor during off-peak agricultural seasons. Such labor has very little opportunity cost.

Although the labor market is small, most of the cultivators hire labor at some time or other during the year (see Table 50). The labor-hiring households are a large majority, even among small farmers cultivating less than 2.5 acres. This may be the result of seasonality in the demand for agricultural labor. At busy periods labor must be hired to supplement family labor, while during slack periods members of the same household will seek jobs in the labor market.

Because of the seasonal variation in demand and supply, the rural labor market is generally informal in nature, and most workers are hired casually, on a daily basis, according to the need. During the survey year, only one-eighth of all farmers and one-half of the large farmers hired workers for a season or for the year. Two-fifths of those hired on a regular basis were children who looked after livestock and were mostly employed for wages in kind—free board, meals, and clothing. Such employment is often determined by the level of absolute poverty in a village rather than by the demand for regular workers by an employer.

Impact of Technology

Technological progress increases the demand for labor in the agricultural sector. In the crop production activity, labor hired on a casual basis accounts for 47 percent of the total labor used in the technologically developed villages, compared with 41 percent in the underdeveloped villages (Table 50). The proportion of hired labor increases even for the small-farmer group. So there is a downward pressure on the supply of hired labor from farming households. This is one of the reasons why the proportion of labor supplied in the agricultural market is lower in the technologically developed villages (20 percent) than in the underdeveloped villages (25 percent), while the labor supplied in the nonagricultural market remains unchanged (Table 49).

Table 51 shows that most of the agricultural labor in the market is supplied by the landless and marginal landholding groups. In the underdeveloped villages, 68 percent of the landless participate in the labor market and 74 percent of their employment is generated by others; the proportions are 13 and 3 percent, respectively, for the large landownership group. In the developed villages, labor supplied against wage is lower than in underdeveloped villages for all landholding groups, and the difference is more pronounced for large landowners. In the nonagricultural sector, also, the participation rate in the market is inversely related to the size of landownership. But unlike in

Table 50—Nature and size of agricultural labor market from the demand side, by landownership group, 1982

	Share of Farmers Hiring Long-Term Workers		Share of Farmers Hiring Daily Labor		Hired Labor as a Share of Total Labor	
Landownership Group[a]	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages
			(percent)			
Small	4.6	2.0	76.2	87.1	30.3	34.4
Medium	17.5	14.3	90.2	96.0	36.0	47.1
Large	54.8	33.3	100.0	100.0	55.9	60.2
All groups	15.4	9.5	84.5	91.1	40.6	46.7

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

Table 51—Participation in labor market for different landownership groups, 1982

	Agriculture				Nonagriculture			
	Share of Households Supplying Wage Labor		Share of Labor Supplied Against Wage		Share of Households Supplying Wage Labor		Share of Labor Supplied Against Wage	
Landownership Group[a]	Underdeveloped Villages	Develloped Villages	Underdeveloped Villages	Develloped Villages	Underdeveloped Villages	Develloped Villages	Underdeveloped Villages	Develloped Villages
				(percent)				
Landless and marginal	67.7	73.7	74.0	52.5	74.0	69.5	51.8	58.3
Small	50.0	39.4	29.0	15.0	66.4	51.9	54.2	47.3
Medium	27.2	17.3	7.8	2.9	37.0	32.1	41.7	40.8
Large	12.9	2.9	2.9	0.3	16.1	32.4	10.0	27.1

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless and marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

agriculture, the supply of labor in the market does not change much with technological advancement. In fact, the supply of wage labor in the nonagricultural market is higher in developed villages for the landless and large landowner groups. Thus the tendency to avoid agricultural wage employment at higher levels of income and to shift to nonagriculture in response to higher employment opportunities puts a downward pressure on the supply of agricultural labor when technology progresses. These forces operate to provide more employment and income to the lower-income groups.

The wages received for hired-out labor (excluding payment in kind) in the two groups of villages are shown in Table 52. The wage rate was higher for nonagricultural labor than for agricultural and higher for male workers than for female. The agricultural wage rate for women was 44 percent lower than for men in the underdeveloped

Table 52—Wage rate received for hired labor, by technology, landholding, and sex of workers, 1982

Technology/Family Landholding	Male Workers		Female Workers	
	Agriculture	Nonagriculture	Agriculture	Nonagriculture
		(Tk/hour)		
Underdeveloped villages	1.53	1.95	0.68	1.16
Less than 0.5 acre	1.46	1.74	0.53	1.21
0.5–2.5 acres	1.61	2.15	1.34	1.25
2.5 acres or more	1.68	2.25	[a]	0.72
Developed villages	1.82	2.86	1.22	1.52
Less than 0.5 acre	1.86	2.46	1.21	1.13
0.5–2.5 acres	1.79	3.03	[a]	1.75
2.5 acres or more	1.63	3.29	[a]	1.91

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Notes: The wages exclude meals as payment in kind. The estimates for female workers for different landholding groups would be unstable, as they are based on a very small number of cases because female participation in the labor market is negligible.

[a] There was no case in this category.

villages. The comparison suggests that technological progress has a positive effect on the wage rate. For male workers, the agricultural wage rate in developed villages was 19 percent higher than in underdeveloped villages, and the nonagricultural wage rate was 47 percent higher.

The wage rate paid by sample farmers for agricultural labor was about 25 percent higher in technologically developed villages than in underdeveloped ones (see Table 53). The difference in wage rate was higher for the small landowners (30 percent) than for large ones (16 percent). Thus, while the landless gain from the higher wages following technological progress, this factor increases inequality in agricultural incomes across the farm-size scale.

Operation of the Labor Market—A Multivariate Analysis

An important limitation of the analysis presented above is that it is based on a partial approach, since only two factors—the size of landownership and technology—are taken into account. The labor market would be affected by a host of other factors, including the wage rate, whose effects also need to be controlled for in assessing the impact of the new agricultural technology. This section attempts to broaden the analysis by applying the multivariate regression technique.

Determinants of Labor Supply

Following Yotopoulos and Lau, and Bardhan,[98] the supply of labor by a rural household is assumed to be governed by the following function:

$$\mathrm{SLBR} = f(\mathrm{OWNL, TECH, CPTL, FSZ, WRKR, FEM, EDCN, LVNG, VWAGE}), \quad (12)$$

where

SLBR = average weekly hours of labor put in by household,

OWNL = amount of land owned by household (in acres),

TECH = amount of land cropped with MVs (in acres),

CPTL = amount of nonland fixed assets owned by household (in Tk 1,000),

FSZ = number of members in household,

WRKR = number of family workers in household,

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[98] Yotopoulos and Lau derive a labor supply function of the household from an indirect utility function, while Bardhan employs a pragmatic approach to explain the labor market participation behavior of peasant households. See Pan A. Yotopoulos and Lawrence J. Lau, "On Modeling the Agricultural Sector in Developing Economies," *Journal of Development Economics* 1 (No. 1, 1974): 105-127; and Pranab K. Bardhan, "Labor Supply Functions in a Poor Agrarian Economy," *American Economic Review* 69 (March 1979): 73-83. Other major works that cover this issue are Lawrence J. Lau, W. L. Lin, and Pan A. Yotopoulos, "The Linear Logarithmic Expenditure System: An Application to Consumption-Leisure Choice," *Econometrica* 46 (July 1978): 843-868; and Mark R. Rosenzweig, "Rural Wages, Labor Supply, and Land Reform: A Theoretical and Empirical Analysis," *The American Economic Review* 68 (December 1978): 847-861.

FEM = number of female workers in household,

EDCN = educational level of head of household (completed years of schooling),

LVNG = standard of living in the village as measured by per capita consumption expenditure, and

VWAGE = wage rate prevailing in the village (in taka per day).

In the utility function of an individual, leisure is considered as one of the consumer goods. Its cost is the wage income that has to be sacrificed if leisure is consumed. This cost would reduce the purchasing power of other consumer goods. So the choice between leisure and consumer goods will be determined by their relative prices, that is, the wage rate and the prices of consumer goods. An increase in income from nonwage sources will shift the indifference curve upward; hence the individual can have more leisure and consumer goods at the same level of relative prices. Thus labor, which is the residual of the time available for work after the consumption of leisure, would be determined mainly by the wage rate, the prices of consumer goods, and the income from nonwage sources. It would be positively related to the wage rate and negatively related to the prices of consumer goods. Owing to the difficulty of measuring the index of the prices of a large number of consumer goods, it has not been possible to incorporate this variable in the labor supply function. Since the labor market is more fragmented, owing to the difficulty of worker mobility, a much larger variation is expected in the wage rate among the cross-section of households than in the prices of consumer goods. The omission of this variable thus may not seriously affect the results.

The main determinants of nonwage income are the assets owned by the household. The variables OWNL, TECH, CPTL, and EDCN have been incorporated to take care of the effect of this factor. The larger the amount of land owned by the household and the proportion of the land devoted to cultivation of MVs, the higher would be nonlabor agricultural income. The nonland fixed assets would provide scope for generating

Table 53—Wage rate paid by sample farmers for agricultural labor in technologically developed and underdeveloped villages, 1982

Landownership Group[a]	Underdeveloped Villages		Developed Villages		Difference in Wage Rate (Developed Over Underdeveloped)
	Number of Farmers Hiring Labor	Wage Rate	Number of Farmers Hiring Labor	Wage Rate	
		(Tk/day)		(Tk/day)	(percent)
Small	86	17.19	128	22.26	30
Medium	74	17.63	72	21.28	21
Large	27	16.34	32	18.90	16

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: The wages include imputed value of payments in kind. The mean wage rate for the entire sample was Tk 19.59, and the standard error of estimate was Tk 0.26. The difference in wage rate between developed and underdeveloped villages was statistically significant for all groups. The Bangladesh Bureau of Statistics estimated the wage rate for the country as a whole at Tk 17.05 for 1982/83.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

self-employment in nonagricultural activities, while education might open up opportunities for shifting to relatively higher-paid employment in service activities and hence for earning higher income from the same amount of labor. Thus, while capital and education may have a positive effect on nonagricultural employment, the higher-income effect would put negative pressure on the supply of labor. The net impact would depend on the magnitude of these two opposite effects.

The decision regarding the consumption of goods and services and the supply of labor is determined at the household level, so the composition of the household and of the working members may also affect the supply of labor. The higher the number of consumers (FSZ) relative to workers, the lower would be the per capita income from labor in the household, and hence the higher would be the supply of labor. The larger the proportion of female workers, the lower would be the supply of labor, since women also have to supply domestic labor and would have less time available for productive work. Thus, other things remaining constant, labor supply would be positively associated with family size and negatively associated with the number of female workers.

In estimating labor-supply functions, questions are raised about appropriate measurement of the wage rate as an independent variable.[99] The wage rate derived from the information on wage earnings and labor hours worked outside the household, if incorporated in the function where the latter is used as the dependent variable, would pose well-known measurement-error problems. For households that do not sell labor, the variable cannot be observed. The problem of simultaneity is also involved because, at the household level, both the amount of labor supplied and the wage rate may be jointly determined by other variables. To avoid these problems, the prevailing wage rate for agricultural labor in the village has been used for all households. As Bardhan points out, the village wage rate may be more exogenous to the individual household than the wage actually received, which may be determined by such factors as the amount of labor supplied and the level of income of the household.

The labor supply functions estimated from the data for all households in the sample, for agriculture and nonagriculture, and for self-employment and wage employment, are reported in Table 54. The total supply of labor seems to be significantly related to all the variables included in the function. The model explains about two-thirds of the variation in the supply of labor among the sample households. A worker supplies on the margin about 30 hours a week, about three-fifths of which are on own account of the household (self-employment) and in the agricultural sector. A larger number of dependents seems to necessitate more work by the earner. This additional work is, however, generated mainly in agriculture and on own account of the household. The coefficient of the family size variable is statistically insignificant and has an opposite sign in the equation for nonagriculture and wage employment. This indicates that such employment may be demand-determined; that is, even if the household is willing to supply additional labor to satisfy the consumption needs of a larger number of dependents, the employment may not be available in the market. A female worker puts in about 11 hours fewer per week than an average worker if she is employed in agriculture, but in nonagriculture the difference is insignificant.

The larger the amount of land owned by the household, the smaller is the supply of labor, which supports the a priori expectation about labor/leisure substitution. Ownership of land, however, gives scope for generating more employment in agriculture, particularly on own account. The value of the coefficient of land in the equation

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[99] Bardhan, "Labor Supply," pp. 74-75.

Table 54—Estimates of labor supply functions for all rural households, 1982

Variable	All Activities	Agriculture	Nonagriculture	Self-employment	Hired Employment
VWAGE	1.10[a]	0.07	1.03[a]	0.58[b]	0.52[c]
	(4.71)	(0.29)	(3.73)	(2.12)	(1.93)
LVNG	−1.47[a]	−0.97[a]	−0.50[c]	−0.33	−1.15[a]
	(−6.51)	(−4.00)	(−1.88)	(−1.22)	(−4.44)
OWNL	−1.09[a]	0.77[c]	−1.86[a]	1.36[c]	−2.45[a]
	(−2.80)	(1.83)	(−4.04)	(2.97)	(−5.49)
TECH	−2.18[a]	1.86[a]	−4.04[a]	0.04	−2.57[a]
	(−2.95)	(2.34)	(−4.65)	(0.46)	(−3.05)
CPTL	0.34[a]	0.16[c]	0.18[c]	0.58[a]	−0.23[b]
	(3.89)	(1.74)	(1.72)	(5.58)	(−2.31)
FSZ	1.28[a]	1.55[a]	−0.27	1.99[a]	−0.71
	(3.34)	(3.78)	(−0.61)	(4.42)	(−1.63)
WRKR	31.06[a]	18.34[a]	12.72[a]	18.03[a]	13.03[a]
	(27.73)	(15.23)	(9.47)	(13.68)	(10.18)
FEM	−11.27[a]	−11.13[a]	−0.14	−2.39	−8.88[a]
	(−4.76)	(−4.38)	(−0.05)	(−0.86)	(−3.29)
EDCN	−0.66[b]	−1.44[a]	0.78[b]	−0.23	−0.43
	(−2.42)	(−4.91)	(2.43)	(−0.71)	(−1.39)
Constant	32.60[a]	28.34[a]	4.26	−4.77	37.36[a]
	(4.38)	(3.54)	(0.88)	(−0.54)	(4.39)
$\bar{R}^2$	0.67	0.47	0.21	0.47	0.27
N	624	624	624	624	624
F	140.6	62.2	19.8	62.4	26.4

Note: Figures in parentheses are estimated t-values. The sample size consists of 624 households, with valid observations for all variables.
[a] This number is significant at the 0.01 level.
[b] This number is significant at the 0.05 level.
[c] This number is significant at the 0.10 level.

of self-employment shows that an additional acre of landownership generates 1.36 hours of additional self-employment a week (about 9 days a year). But the positive income effect of landownership reduces the supply of labor in the market by about 2.45 hours a week (16 days a year). Thus, on balance, the total supply of labor is reduced.[100] The results also indicate that the larger the amount of land owned, the less is the need to work in nonagricultural activities. Education gives additional scope for working in the nonagricultural sector, but the higher-income effect of education and the higher social status of the educated worker operate to reduce the worker's supply of labor in agriculture. On balance, the better educated supply less labor in agriculture and on others' account. Among the income variables, only capital seems to increase the supply of labor. It reduces supply for the market, but the positive effect on creation of employment on own account more than compensates for the negative effect, in both agricultural and nonagricultural activities.

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[100] Values of regression coefficients reported in the table are those obtained by the OLS method. Since some of the cases have zero values for the dependent variable (the number was large for the category of hired employment), the censored regression method is more appropriate for estimation of the supply functions for different categories of employment. The equations were estimated using the tobit method and the parameter values were found to be somewhat different, but the general conclusions remained valid. The OLS estimates were chosen for presentation because the values of the parameters of the specific variables in functions for different categories of labor add up to the parameter for that variable in the supply function for total labor.

The supply of labor responds positively to the wage rate, but mostly for nonagricultural labor. For agricultural labor, the coefficient of the wage variable is statistically insignificant. This is found to be the case for all landownership groups from separate estimates of the supply functions for agricultural labor. The estimated coefficient of the wage rate, valued at the arithmetic mean of the variable, gives an elasticity of supply of nonagricultural labor at 0.71.

Another variable that is found to significantly affect the supply of labor is the standard of living in the village. This variable is measured by the per capita consumption expenditure at the village level. The value of the coefficient is negative and highly statistically significant, indicating that the higher the standard of living in the villages, the smaller is the supply of labor by its households. This variable affects mostly the supply of labor for the market—the negative coefficient in the equation for wage employment is statistically highly significant. The coefficient for self-employment is also negative but not statistically significant. This result suggests that improvement in economic conditions in a village—from whatever sources—would reduce the supply of labor for the market, which would give scope for more employment for workers from neighboring low-income villages or put an upward pressure on the wage rate, or both.

For the present purpose, the coefficient of the technology variable is the point of interest. After controlling for the effects of other variables, the coefficient of the technology variable is negative, indicating that diffusion of the modern technology would depress the supply of labor. The value of the coefficient suggests that an increase of 1 acre under MVs would reduce the supply of labor on the margin by 2.2 hours a week (14 days a year). Technological progress creates opportunities for more employment in agriculture. The value of the coefficient in the equation for agriculture is found to be positive and statistically significant. But by raising incomes, it reduces the need to work in nonagricultural activities. The negative effect on nonagricultural labor is more pronounced than the positive effect on agricultural labor. The difference is presumably due to the income effect of technological progress. Technological progress also reduces the supply of labor for the market. The value of the technology coefficient in the equation for wage employment indicates that an increase of 1 acre under the new technology would reduce the supply of wage labor by 2.6 hours a week (17 days a year).

Table 55 reports the estimated labor supply functions for the landless and marginal landowning households. A close scrutiny of the results shows a behavioral pattern similar to that for all households in the sample, with a few exceptions. The coefficient of the size of landownership is not significant in either of the equations, which is understandable as this group owns only up to 0.5 acre of land. A worker in this group supplies about 30 hours of labor a week, only 2.2 percent less than other groups, but unlike the landowning groups, two-thirds of the labor is supplied to the market—mostly in agricultural activities. The total supply of labor is positively related to the wage rate, but the response is mostly for labor on own account. It appears that when the wage rate goes up, this group reduces hiring of outside labor and replaces it with more self-exploitation of family labor.

Technological progress generates more additional agricultural employment for the landless than for the landowning groups. This is achieved by substituting agricultural for nonagricultural labor. The positive effect on agricultural labor is more pronounced than the negative effect on nonagricultural labor. On balance, the technology has a

Table 55—Estimates of labor supply functions for landless and marginal landowning households, 1982

Variable	All Activities	Agriculture	Nonagriculture	Self-employment	Hired Employment
VWAGE	1.40[a]	0.57	0.89[c]	1.55[a]	−0.15
	(3.25)	(1.41)	(1.67)	(2.74)	(−0.27)
LVNG	−1.41[a]	−1.55[a]	0.14	0.02	−1.42[a]
	(−3.92)	(−3.71)	(0.31)	(0.03)	(−3.00)
OWNL	−5.00	−2.21	−2.80	0.24	−5.25
	(0.68)	(0.26)	(−0.30)	(0.03)	(−0.54)
TECH	1.14	8.24[b]	−7.10[a]	4.76	−3.61
	(0.36)	(2.21)	(−1.68)	(1.13)	(−0.85)
FSZ	3.52[a]	3.12[a]	0.40	3.96[a]	−0.44
	(3.74)	(2.85)	(0.32)	(3.20)	(−0.36)
WRKR	30.38[a]	19.93[a]	10.45[a]	10.43[a]	19.95[a]
	(12.52)	(7.07)	(3.28)	(3.27)	(6.23)
FEM	−2.41	−13.75[a]	11.34[b]	14.85[a]	−17.26[a]
	(−0.58)	(−2.89)	(2.08)	(2.71)	(−3.14)
EDCN	−0.15	−1.31[c]	1.15	0.88	−1.03
	(−0.23)	(−1.76)	(1.38)	(1.05)	(−1.23)
Constant	12.51	15.09	−2.58	−44.88[a]	57.39[a]
	(0.99)	(1.02)	(−0.16)	(−2.67)	(3.42)
$\bar{R}^2$	0.68	0.41	0.17	0.31	0.26
N	191	191	191	191	191
F	52.28	17.02	5.81	11.49	9.35

Note: Figures in parentheses are estimated t-values.

[a] This number is significant at the 0.01 level.

[b] This number is significant at the 0.05 level.

[c] This number is significant at the 0.10 level.

positive effect on labor supply for the landless, although it is not statistically significant. It is also interesting to note that, like the landowning groups, the landless reduce the supply of labor to the market in response to technological progress.

Determinants of Demand for Agricultural Labor

The survey collected information on the demand for labor only for crop-production activity. The information was collected from the farming households at the crop level for three agricultural seasons. Table 56 presents the information for different groups of farm households. The total demand for labor in the crop production activity in the developed villages was about 27 percent higher than in underdeveloped villages. Most of the increase, however, was on account of hired labor. Compared with underdeveloped villages, an average household in the developed villages used 42 additional days of labor, 34 days being met by employment of hired workers. The additional self-employment for family labor is mostly on account of small-farm households. The demand for hired labor was about 56 percent higher in developed villages, and the additional employment was generated more on the small farms (131 percent) than on the large ones (19 percent). It appears that large farmers kept the upward pressure on the wage rate low (Table 53) by hiring labor relatively less than small and medium farmers.

Table 56—Use of labor in crop production in developed and underdeveloped villages, by amount of land owned, 1982

	Family Labor			Hired Labor			Total Labor		
Landownership Group[a]	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference
	(8-hour days/household)		(percent)	(8-hour days/household)		(percent)	(8-hour days/household)		(percent)
Small	52.7	72.0	36.6	19.8	45.8	131.1	72.5	117.8	62.5
Medium	118.4	106.3	−10.2	66.5	94.8	42.6	184.9	201.1	8.8
Large	155.1	155.5	0.3	196.6	234.4	19.3	351.7	389.9	10.9
All groups	90.9	98.5	8.4	61.3	95.3	55.5	152.2	193.8	27.3

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: The table excludes the functionally landless households. A few of them were engaged in farming and used farm labor, which is not accounted for.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

The following demand function for hired labor was estimated from the data:

$$\begin{aligned} \text{DLBR} = {} & \underset{(4.23)}{68.29} + \underset{(10.74)}{8.72}\,\text{LAND} + \underset{(13.11)}{27.78}\,\text{TECH} - \underset{(-0.58)}{1.64}\,\text{WRKR} \\ & - \underset{(-2.99)}{2.27}\,\text{VWAGE} - \underset{(-4.00)}{0.48}\,\text{TNC}; \end{aligned} \tag{13}$$

$\bar{R}^2 = 0.49, \quad F = 95.9, \quad N = 461,$

where

DLBR = number of labor days hired from outside the household in the crop production activity,

LAND = total cropped area (in acres),

TECH = area devoted to cultivation of MVs,

WRKR = number of family workers in household,

TNC = total cropped area under tenancy (in acres),

VWAGE = wage rate estimated at the village level (in taka per day).

The figures within parentheses are the estimated t-values of the coefficient. As expected, the demand for labor is positively associated with cropped land but negatively associated with the proportion of area under tenancy. The wage rate, measured at the village level, affects the demand for labor. The coefficient of the variable is statistically significant at less than 1 percent probability of error. The value of the coefficient evaluated at the mean level of the variable gives a wage elasticity of demand for labor at −0.58. The coefficient of the technology variable suggests that technological progress would increase the demand for labor significantly. The estimated t-value of the regression is extremely high. The value of the coefficient indicates that an increase in area under the new technology by 1 acre would increase the demand for hired labor in crop production by about 28 days.

The labor demand function has also been estimated with the alternative specification of the wage rate at the household level. The results are the following:

$$\begin{aligned} \text{DLBR} = {} & \underset{(4.80)}{73.19} + \underset{(10.78)}{8.70}\,\text{LAND} - \underset{(-0.56)}{1.59}\,\text{WRKR} + \underset{(13.48)}{28.06}\,\text{TECH} \\ & - \underset{(-4.08)}{0.48}\,\text{TNC} - \underset{(-3.55)}{2.53}\,\text{HWAGE}; \qquad (14) \end{aligned}$$

$\bar{R}^2 = 0.51, \quad F = 97.4, \quad N = 408,$

where HWAGE is the wage rate in taka per day paid by the household and other variables, as defined earlier. The results are similar except that the value of the coefficient for the wage rate increases and its statistical significance improves. The wage elasticity of demand for labor at this value is estimated at −0.65.

Impact of Technology on the Wage Rate

As mentioned earlier, the survey did not collect information on in-migration of labor from outside the sample or on demand for labor in nonfarm activities, so it is not possible to balance the supply and demand for labor in order to estimate a simultaneous equation system for determination of the wage rate.

The single equation estimates of the supply and demand for agricultural labor, however, indicate that technological progress may significantly affect the wage rate. It generates opportunities for additional self-employment in agriculture, thus reducing the supply of labor in the market by the landowning households. On the other hand, it increases the demand for farm labor in the market, so a gap develops between the demand for and supply of labor by the landowning households in the technologically developed villages. The gap may be filled by a supply of more labor from the landless group within the villages or by out-migration of labor from labor-surplus households in villages where the technology has not yet made much progress. In this way, the forces in the labor market may operate to redistribute income from higher- to lower-income groups within the developed villages, and from developed to relatively underdeveloped villages. The results also show that as technology progresses, even the landless in the developed villages supply less labor to the market. This indicates the possibility of considerable in-migration of labor from underdeveloped villages, without which there would be an upward pressure in the wage rate for clearing the labor market.

In order to see the impact of the technology on the wage rate, a wage equation was estimated, incorporating all variables that significantly affect the supply and demand for agricultural labor. After elimination of the statistically insignificant variables, the following wage equation has been obtained:

$$\begin{aligned} \text{VWAGE} = {} & \underset{(46.95)}{19.32} - \underset{(-4.19)}{0.26}\,\text{LAND} + \underset{(10.59)}{1.25}\,\text{TECH} + \underset{(2.38)}{0.44}\,\text{TNC} \\ & - \underset{(-4.10)}{0.72}\,\text{WRKR} + \underset{(1.71)}{0.10}\,\text{EDCN}; \qquad (15) \end{aligned}$$

$\bar{R}^2 = 0.22, \quad F = 26.1, \quad N = 408.$

Figures within parentheses are estimated t-values. If wages are exogenously determined, all variables would be expected to be statistically insignificant. But nearly a fifth of the variation in wage rate across the villages is explained by the above variable. Technology seems to be the most important variable affecting the wage rate. This is also found to be the case when wage rate is measured at the household level, as shown by the following equation:

$$\begin{aligned} \text{HWAGE} = {} & \underset{(51.12)}{19.50} - \underset{(-3.56)}{0.23\,\text{LAND}} + \underset{(9.84)}{1.24\,\text{TECH}} \\ & - \underset{(-3.72)}{0.68\,\text{WRKR}} + \underset{(2.01)}{0.39\,\text{TNC}}; \end{aligned} \tag{16}$$

$\bar{R}^2 = 0.18$, $F = 26.5$, $N = 408$.

Conclusions

Modern technology affects the labor market mainly through the income variable. At higher levels of income, households substitute leisure for labor and supply less labor in the market. This redistributes employment from higher- to lower-income groups. Even the poor supply less labor in the market as income increases with technological progress. But the demand for agricultural labor goes up because of the higher labor intensity of MVs, thus putting an upward pressure on the wage rate and increasing wage earnings from the same amount of labor. These forces in the labor market may also operate, by promoting rural-rural migration, to redistribute some employment and income from technologically developed to underdeveloped villages. Unfortunately, the survey did not collect any information on migration, so a direct testing of the hypothesis is not possible.

8

LINKAGE EFFECTS OF AGRICULTURAL GROWTH

It was shown in Chapter 4 that diffusion of the new technology would substantially increase the income from crop production. The crop sector accounts for about 77 percent of agricultural income in the country. Thus technological progress is expected to have a significant effect on the growth of agricultural income.

Agricultural growth involves linkages to nonfarm sectors, and the poor may gain indirectly through the generation of employment in these activities.[101] The linkages may be generated from the supply side through investment of the new surpluses by the landowners, or from the demand side through income-induced expenditure on nonfarm goods and services, or from both. The growth of agricultural income may also increase the opportunity for investment and employment in nonfarm rural activities through its effects on the demand for such items as (1) irrigation equipment and other modern agricultural inputs produced in the nonagricultural sector, (2) services for processing and marketing additional surplus produce, and (3) trade and transport services arising from the additional purchase of nonfarm products.

Empirical studies for a number of developing countries show that the linkage effects of agricultural growth can be substantial.[102] Bell, Hazell, and Slade concluded from a study of the Muda irrigation project in Malaysia that for each dollar of agricultural income created directly by the project, an additional 80 cents of value added was created indirectly in the local nonfarm sector. In a study of interrelationships between agricultural and industrial growth performance in India, Rangarajan found that a 1.0 percent addition to the agricultural growth induced a 0.5 percent incremental growth of industrial output and 0.7 percent additional growth of national income. Recognizing the importance of such expenditure-induced growth linkages, Mellor argued that, contrary to conventional wisdom, agriculture can play the role of the leading sector in the development process.[103]

This chapter attempts to assess the nature and extent of such linkage effects by analyzing the expenditure pattern of the sample households in the technologically developed and underdeveloped villages. The data on expenditures were collected from two types of interviews. Information on daily necessities was collected on a weekly basis by asking households about consumption and purchases of these items for the week preceding the interview. This survey was conducted 8 times in 1982 during busy, normal, and slack seasons of economic activity in the sample villages. The expenditure on these items for the whole year was then estimated on the basis of the eight weeks' data. The information on expenditures on major items, such as clothing, household effects, education, recreation, health, and acquisition and repair of fixed assets, was collected four times during the year, retrospectively on a quarterly basis.

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[101] Mellor, *The New Economics of Growth.*

[102] Clive Bell, Peter Hazell, and Roger Slade, *Project Evaluation in Regional Perspective* (Baltimore and London: Johns Hopkins University Press, 1982); C. Rangarajan, *Agricultural Growth and Industrial Performance in India,* Research Report 33 (Washington, D.C.: International Food Policy Research Institute, 1982).

[103] Mellor, *The New Economics of Growth.*

Expansion of the Market: An Analysis of Consumption Patterns

Methodology

The commodities and services consumed have been classified into the following groups for study of the consumption-induced linkages:

Crops:	Rice, wheat, other grains, roots, vegetables, pulses, fruits, spices, betel nuts and betel leaves, rice husks, jute sticks
Forestry:	Firewood, leaves
Livestock:	Meat, milk, eggs, cow dung
Fishery:	Raw and dried fish
Rural processing:	Gur (raw sugar), bidi (indigenous cigarettes), tobacco, mustard oil, sweets, handloom clothes, tailoring
Urban processing:	Sugar, tea, cigarettes, soybean oil, coconut oil, kerosene, electricity, matches, soap, soda, toiletries, mill-made clothing, ready-made garments, imported new and old clothes, shoes
Services:	Education, health, transport, personal services, social services, religious services.

The impact of the growth of income on demand for the various goods and services has been studied by estimating an Engel function of the following type on the cross-section data:[104]

$$E_i = \alpha_i + \beta_i E + Y_i E \log E + \mu_i \log F + \lambda_i E \log F, \qquad (17)$$

where E is the per capita expenditure of the household, E_i is the amount of expenditure incurred on the consumption of goods in the ith group, and F is the number of persons in the household. This is a nonlinear function that allows for variation in the marginal budget share for the ith group, MBS_i, at different levels of income, which can be derived as follows:

$$MBS_i = \beta_i + Y_i(1 + \log E) + \lambda_i \log F \qquad (18)$$

The size of the family would have an important bearing on the economic position of the household at a given level of income, so it has been included in the equation as an important socioeconomic variable influencing consumption behavior of the household.

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[104] For details of this form of the Engel function and its characteristics, see Hazell and Roell, *Rural Growth Linkages*. pp. 22-24.

To avoid the problem of heteroscedasticity, that the variability in the E_i increases with the explanatory variable E, the function has been fitted in the following expenditure-share form, which is derived from equation (18).

$$S_i = \beta_i + \alpha_i/E + Y_i \log E + \mu_i \log F/E + \lambda_i \log F, \qquad (19)$$

where $S_i = E_i/E$ is the share of the expenditure. The disadvantage of estimating the share equation is that the value of $\bar{R}^2$ is typically small,[105] but it ensures the desirable property that the sum of the marginal budget share is equal to unity.[106]

Since per capita income is a better measure of the economic standing of the household than is household income, the expenditure variable has been measured in per capita terms. But the household size has been included so that the model permits this variable to influence both the intercept and the slope of the individual Engel functions.

Discussion of Results

The estimated parameters for the Engel function are reported in Table 57. As the function is estimated in the expenditure-share form, the value of $\bar{R}^2$ is, in general, low.

Table 57—Estimates of Engel function for rural households, 1982

Commodity Group	Estimated Values of the Parameter					$\bar{R}^2$
	α	β	Y	μ	λ	
Crops	−230.00 (4.73)	2.779 (18.15)	−0.2575 (−14.86)	−2.251 (−0.64)	−0.0017 (−0.99)	0.44
Forestry	23.70 (1.43)	0.031 (0.60)	−0.0012 (0.20)	−0.650 (0.54)	−0.0021 (−3.53)	0.08
Livestock	−0.38 (−0.02)	−0.116 (−2.39)	0.0195 (3.54)	1.286 (1.157)	0.0004 (0.76)	0.08
Fishery	−40.90 (−3.53)	0.061 (1.68)	−0.0007 (−0.02)	2.660 (3.18)	−0.0016 (−3.93)	0.09
Rural processing	92.80 (3.79)	−0.342 (−4.44)	0.0502 (5.76)	−3.010 (−1.71)	0.0020 (2.25)	0.06
Urban processing	39.90 (1.41)	−0.409 (−4.61)	0.0596 (5.92)	1.530 (0.75)	−0.0005 (−0.49)	0.12
Services	114.70 (3.29)	−0.990 (−9.03)	0.1255 (10.10)	0.380 (0.15)	0.0033 (2.64)	0.28

Source: Estimates based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Notes: The function was estimated in the following form:

$$S_i = \beta_i + \alpha_i/E + Y_i \log E + \mu_i F/E + \lambda_i F,$$

where S_i is the share of the commodity group in total consumption expenditure, E is the per capita consumption expenditure, and F is the number of persons in the household. Figures in parentheses are estimated t-values.

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[105] The value of $\bar{R}^2$ for this equation measures the extent to which the variation of the average budget share of the commodity across the sample is explained by the variation in income. If the marginal budget share is equal to the average share, that is, the expenditure elasticity of demand is unity, the average budget share would be the same across the income level and the value of $\bar{R}^2$ would be zero.

[106] S. J. Press and H. S. Houthakker, *The Analysis of Family Budgets* (Cambridge: Cambridge University Press, 1971), pp. 55-56.

For forestry, livestock, fishery, and rural processing, the value of $\bar{R}^2$ is less than 0.10, indicating that the share of these commodities in total expenditure does not vary much with the level of income, which suggests that the expenditure elasticity of demand is close to unity. But the value $\bar{R}^2$ is relatively high for crop-sector outputs and services, which indicates that the expenditure elasticity of demand for them deviates significantly from unity. The value of the coefficient, Y, shows what happens to the marginal budget share as the level of income changes. The estimated value of this variable is significantly negative for crop-sector output, which shows that the incremental expenditure on these commodities declines with increases in income. The value is significantly positive for livestock, manufactured goods, and services.

The estimates of marginal budget share and the expenditure elasticity of demand derived from the parameters of the Engel function are reported in Table 58. About two-thirds of the expenditure is allocated to commodities produced in the crop and forestry sectors, where the share of land in value added is very high. But the marginal budget share for these commodities is 53 percent, which suggests that with increases in income, people spent proportionately much less on these items. The expenditure elasticity of demand is estimated at 0.77 for crops and 0.79 for forestry products.[107] Among agricultural commodities, livestock and fishery products have elastic demand; the marginal share of these products is 11 percent, while the average share is 8 percent. Manufactured goods have a share of 17 percent of the total budget; nearly 56 percent of these goods are produced in rural areas. These commodities also have elastic demand; the share of them in the incremental expenditure is nearly 23 percent. The expenditure is, however, more elastic for goods produced in urban areas.[108] With increased income, the marginal share of manufactured goods of rural origin increases less than proportionately.

But the highest elasticity of demand is for rural service-sector activities, in which labor's share of income is very high. Nearly 13 percent of the enlarged market for

Table 58—Estimates of marginal budget shares and expenditure elasticity of demand, 1982

Commodity Group	Average Budget Share	Marginal Budget Share	Expenditure Elasticity of Demand
	(percent)		
Crops	64.94	50.26	0.77
Forestry	3.59	2.82	0.79
Livestock	4.22	5.80	1.38
Fishery	3.95	5.01	1.27
Rural processing	9.51	11.22	1.18
Urban processing	7.51	11.21	1.49
Services	6.21	13.46	2.17

Source: Estimated from Table 57.

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[107] Not all commodities in this group have expenditure elasticity less than unity. Pulses and fruits have highly elastic demand, but their share of the budget was less than 4 percent. See Appendix, Table 73.

[108] The manufactured goods that have elastic demand are bidi (cigarettes), tobacco, kerosene, washing soda, and old readymade garments that are imported from abroad for the poor. As incomes increase, cigarettes are substituted for bidi and tobacco, soaps for washing soda, and electricity for kerosene in areas of developed infrastructure. The other substitute commodities are gur (raw sugar) and sugar; gur is produced in villages. While the expenditure elasticity of gur is lower than that of sugar, it is still higher than unity. See Appendix, Table 73.

goods and services goes to service activities. The expenditure elasticity is estimated at about 2.2, indicating that with a 10 percent increase in total expenditure, the demand for service-sector activities would increase by about 22 percent. All nonfarm goods and services together share about 47 percent of the incremental expenditure and have elasticity of 1.5.

To assess the impact of technological progress on the demand for various types of commodities, the Engel function has been estimated separately for the technologically developed and underdeveloped villages. The estimates of demand derived from the parameters for the two groups of villages are reported in Table 59. It will be noted from the results that for both groups of villages the pattern of expenditure is almost the same as that obtained earlier for the entire sample. Crops and forestry products have inelastic demand, while services and urban manufactured products have the most elastic demand. With technological progress, the difference becomes even more pronounced because of the increase in income. The per capita income in developed villages was 22 percent higher than in underdeveloped ones (see Chapter 9). In the underdeveloped villages, 42 percent of the incremental expenditure was for cereals, but in the developed villages the share was 31 percent. The expenditure elasticity of demand for cereal is 0.64 in the developed villages, compared with 0.79 in the underdeveloped villages. Roots and vegetables have inelastic demand; their marginal budget share and the value of elasticity are lower in the developed villages. Pulses have highly elastic

Table 59—Expenditure pattern of households in developed and underdeveloped villages, 1982

Commodity Group	Underdeveloped Villages Average Share	Underdeveloped Villages Marginal Share	Underdeveloped Villages Expenditure Elasticity	Developed Villages Average Share	Developed Villages Marginal Share	Developed Villages Expenditure Elasticity
	(percent)			(percent)		
Crops	67.0	56.5	0.84	62.9	45.0	0.71
Cereals	53.0	42.1	0.79	49.1	31.2	0.64
Pulses	1.1	1.3	1.24	0.8	1.2	1.56
Roots and vegetables	5.4	4.7	0.87	4.8	3.1	0.65
Fruits	2.1	3.4	1.62	1.9	3.0	1.57
Spices	3.4	2.9	0.84	3.7	3.3	0.91
Betel nuts and betel leaves	0.9	1.4	1.55	1.3	1.3	1.00
Rice husks and jute sticks	1.0	0.7	0.70	1.3	1.7	1.30
Forestry	4.1	3.2	0.78	3.1	2.7	0.88
Firewood	2.0	2.6	1.29	1.5	2.1	1.38
Leaves	2.1	0.6	0.30	1.6	0.7	0.43
Livestock	4.4	5.7	1.29	4.0	6.4	1.59
Meat and eggs	1.6	3.2	2.00	2.1	4.4	2.10
Milk	0.9	1.8	1.93	1.3	2.4	1.92
Cow dung	1.9	0.6	0.33	0.7	−0.4	−0.58
Fishery	3.6	4.2	1.19	4.4	5.3	1.22
Manufactures	16.7	22.9	1.37	17.5	22.7	1.29
Rural origin	9.5	12.4	1.30	9.5	10.3	1.09
Urban origin	7.2	10.5	1.46	7.8	12.4	1.56
Services	4.2	7.5	1.79	8.2	17.9	2.18

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Notes: Figures are derived from commodity-specific Engel functions estimated from household-level data. Parts may not add to totals because of rounding.

demand but their average and marginal consumption are lower in developed villages, presumably because of reallocation of land from pulses to MV rice. Among food items, meat, eggs, and milk have expenditure elasticities of 2.0 and their share of the marginal budget is 6.8 percent in developed villages, compared with 5.0 percent in underdeveloped villages. The most significant difference in the marginal budget share is found for service-sector activities. In the underdeveloped villages only 7.5 percent of the incremental expenditure was for these items; in the developed villages, the share was about 18 percent. Only for rural manufacturing is the value of the expenditure elasticity lower in the developed villages, but the absolute value is still greater than unity. The above findings indicate that the market for livestock and fishery products, manufacturing, and services expands more than proportionately as technological progress increases rural income. The most significant effect is on service activities, where labor's share of income is high compared with other commodity groups.

Reinvestment of Surplus

Investment defined as additions to the value of fixed assets and working capital is classified here into two broad groups—directly productive investment and other investment. Investments in agricultural and nonagricultural enterprises are regarded as directly productive investment. Agricultural investment includes expenditures on land development (such as leveling land, fencing, clearing water hyacinths, raising small embankments in fields for improved water control, and digging field channels for irrigation); purchase of agricultural machinery and tools, equipment, and draft animals; purchase of cattle and poultry for rearing; and expenditures on pond digging and tree planting. Nonagricultural investment includes purchases of industrial machinery and tools, transport equipment, and shares and debentures, and additions to fixed and working capital for trade and business. Changes in the stock of output and raw materials for agriculture and industry could not be taken into account due to lack of information. Nonmonetary investment in the form of use of family labor has been imputed by the prevailing market wage rate.

The second group, other investment, includes expenditures on construction and improvement of housing and cattle sheds, education of children, digging of wells and tubewells for drinking purposes, and construction of latrines. These may be termed social investments for formation of human capital, which may increase the productivity of labor in the long run. Expenditures on household durables, such as furniture and fixtures, electrical goods, and metal and earthen utensils, have also been treated as investment.

A significant number of households have been engaged in transactions that may be called transfers. These include such items as purchase and sale of land, receipt and repayment of loans and interest, expenses on account of litigation, and theft of property. At the aggregate level the net transfers should be zero. For the sample under study, however, the net transfer was found to be significantly positive, indicating the possibility of an underreporting of negative transfers, which people tend to suppress. Because of the conceptual problems involved, these items have not been included in investment.

The pattern of investment in the technologically developed and underdeveloped villages can be reviewed in Table 60. Total investment per household was almost the same for the two groups, but because of higher levels of expenditure, the rate of investment was lower in the developed villages (14 percent) than in the underdeveloped villages (17 percent). The difference is mainly on account of the directly productive investments, which accounted for 11.7 percent of the total expenditure in under-

Table 60—Pattern of investment in technologically developed and underdeveloped villages, 1982

Type of Investment	Amount per Household: Underdeveloped Villages	Amount per Household: Developed Villages	As Share of Gross Investment: Underdeveloped Villages	As Share of Gross Investment: Developed Villages	As Share of Total Expenditure: Underdeveloped Villages	As Share of Total Expenditure: Developed Villages
	(Tk)		(percent)			
Directly productive investment						
Agriculture	1,039	881	32.9	28.2	5.6	3.9
Land development	106	135	3.4	4.3	0.6	0.6
Agricultural tools and equipment	408	75	12.9	2.4	2.2	0.3
Draft animals and livestock	494	645	15.6	20.6	2.6	2.9
Other agriculture	31	26	1.0	0.8	0.2	0.1
Nonagriculture	1,132	769	35.9	24.6	6.1	3.4
Industry	225	29	7.1	0.9	1.2	0.1
Business	874	711	27.7	22.7	4.7	3.1
Transport	33	29	1.1	1.0	0.2	0.1
Other investment	986	1,477	31.2	47.2	5.3	6.5
Housing	727	1,186	23.0	37.9	3.9	5.3
Sanitation	27	29	0.9	0.9	0.1	0.1
Consumer durables	232	262	7.3	8.4	1.3	1.2
Total investment	3,157	3,127	100.0	100.0	16.9	13.9
Total expenditure (consumption plus investment)	18,640	22,600	...	...	100.0	100.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

developed villages, compared with only 7.3 percent in the developed villages. Two items on which households in developed villages spent proportionately more are construction of housing and acquisition of livestock. But the rate of investment in agricultural equipment and tools, cottage industry, and business was significantly higher in the underdeveloped villages.

Table 61 shows the pattern of investment for different landownership groups. As expected, the rate of investment is positively associated with the size of landownership. For the landless and small landowning households, the rate of investment was almost the same in the technologically developed and underdeveloped villages. But the medium and large landowners in the developed villages accumulated proportionately much less than their counterparts in the underdeveloped villages. It is interesting to note that the large landowners invested relatively less for capital formation in agriculture than did the small and medium landowners. A similar finding was reported by Rahman from a survey of two areas in 1975.[109]

Capital formation in nonagricultural activities was significantly higher in the technologically underdeveloped villages. Since the scope for accumulation of land is limited in these villages, rural households try to increase income through accumulation in nonagriculture, as the market for nonfarm goods and services expands with technological

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[109] Atiq Rahman, "Surplus Utilisation and Capital Formation in Bangladesh Agriculture," *The Bangladesh Development Studies* 8 (No. 4, 1980): 21-46.

Table 61—Pattern of investment for different landownership groups, 1982

Landownership Group[a]	Directly Productive Investment		Other Investment		
	Agriculture	Nonagriculture	Housing and Sanitation	Consumer Durables	Total
	(percent of household expenditure)				
Underdeveloped villages					
Marginal	2.3	3.8	1.7	0.7	8.5
Small	5.4	2.1	3.5	2.0	13.0
Medium	7.1	5.3	5.2	1.0	18.6
Large	5.8	14.3	4.9	2.0	26.3
Developed villages					
Marginal	1.2	2.2	4.0	1.1	8.4
Small	6.2	1.6	3.6	1.1	12.6
Medium	3.6	6.0	4.2	1.1	14.9
Large	3.5	2.7	10.4	1.4	18.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

progress. But this opportunity is taken up more by the upper-income households. In the underdeveloped villages, nonagricultural investment as a proportion of total expenditure is about 14 percent for the large landowning households, compared with 2-5 percent for the other landholding groups.

The information presented in this section thus leads to the following main conclusions. First, technological progress does not necessarily lead to higher capital formation in agriculture. The reason for this may be that investment in irrigation, which is the main vehicle of technological progress, is made by the government. Second, expansion of the market for nonfarm goods and services seems to stimulate the most nonagricultural investment in villages where technology has made the least progress. This may occur because the new technology provides an opportunity for increasing income from the land for households in the developed villages. Since such an opportunity is lacking in the underdeveloped villages, those households look for opportunities in the nonfarm sector to increase their incomes. Third, income from investment-induced linkages tends to be unequally distributed. Because of the higher levels of income, accumulated savings, and better access to financial institutions, the large landowners can respond more readily to opportunities of investment in the nonfarm sector than can the landless and small landowners, although the latter may gain from creation of additional employment in these activities.

Impact on the Land Market

A factor to which much emphasis has been given in the literature[110] to explain the negative income-distribution effects of modern technology is the impact of agricultural surplus on the rural land market. By increasing the profitability of cultivation, the new technology inflates the surplus of the large landowners and increases the value of land. On the other hand, it makes cultivation difficult for the marginal landowners, since the working capital requirement for cultivation of the new varieties is substantially higher, and the poor have little access to credit from financial institutions. It is argued that with technological progress these forces will operate to increase transactions in the rural land market, and the large landowners will buy out the marginal farms, leading to further accumulation of land by the rich and a higher concentration of income.

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[110] See, for example, Pears, *Seeds of Plenty.*

The survey collected information on the source of acquisition of each plot of land owned by the sample households. This information can be used to empirically test the above hypothesis. If technological diffusion is associated with high transactions in the land market, the proportion of land obtained through the market would be higher for households in the technologically developed villages than for those in the underdeveloped villages. The findings reported in Table 62 tend to support the hypothesis. In developed villages, 63 percent of total land owned at the time of the survey was inherited from parents, compared with 72 percent for households in the underdeveloped villages, which suggests that the households in developed villages had been engaged in land transactions after inheritance much more than those in underdeveloped villages. The proportion of land acquired through purchase was reported at 32 percent for the developed villages and 25 percent for the underdeveloped villages.

A more direct test of the hypothesis could be made with information on land purchases and sales during the year of the survey. An important limitation on this information is that investment in land is a large, indivisible expenditure, and the household may have to save for a number of years to buy a piece of land, so it is difficult to get a representative picture of the behavior of an individual household from information for one year. A representative picture may be obtained by looking at mean values for a large number of households in a homogeneous group that would incur such expenditures every year.

The proportion of households that participated in the land market in 1982, and the extent of transactions involved, can be reviewed in Table 63, which shows the following major points. The land market is very thin. Less than 10 percent of the households participated in the market during the survey year and the maximum amount of transactions (land sold or purchased) was less than 2 percent of the amount of land. The net transaction was positive in the developed villages and negative in the underdeveloped villages. The accumulation of land in the developed villages was partly at

Table 62—Sources of landholdings in technologically developed and underdeveloped villages, from inheritance to 1982

Source of Owned Land	Underdeveloped Villages: Land Owned per Household	Underdeveloped Villages: Share of Total Land	Developed Villages: Land Owned per Household	Developed Villages: Share of Total Land
	(decimals)	(percent)	(decimals)	(percent)
Inheritance from parents	162	72.0	142	62.8
Inheritance from in-laws	3	1.3	7	3.1
Purchased	57	25.3	72	31.9
Other	3	1.3	5	2.2
Total	225	100.0	226	100.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Notes: A decimal is 1/100 of an acre. Parts may not add to totals because of rounding.

Table 63—Transactions in the land market in technologically developed and underdeveloped villages, 1982

Landownership Group[a]	Amount Transacted				Net Accumulation as Share of Owned Land
	As Share of Households		As Share of Owned Land		
	Purchased Land	Sold Land	Purchased Land	Sold Land	
			(percent)		
Underdeveloped villages	8.8	8.2	1.11	1.79	−0.68
Marginal and small	4.9	8.8	2.05	4.98	−2.93
Medium	13.6	4.9	0.92	0.70	0.22
Large	22.6	2.9	0.85	1.31	−0.46
Developed villages	9.8	8.8	1.73	1.30	0.43
Marginal and small	5.0	7.0	1.32	2.18	−0.86
Medium	16.3	13.8	1.47	2.09	−0.62
Large	21.6	8.1	2.03	0.30	1.73

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

the expense of the small landowners. For the small farmer group, the proportion of land sold was much less in the developed villages than in the underdeveloped ones, which suggests that by increasing income per unit of land, technological progress reduces the necessity to sell land. The highest accumulation, however, was by the large landowning groups in the developed villages. They increased the size of landownership by 1.7 percent during the survey year.

The results seem to support the hypothesis of the negative effect of technological progress on income distribution through accumulation of land. The impact, however, is very small. During 1982, the households in the developed villages accumulated only 0.4 percent of the holdings. At the rate of accumulation (1.7 percent a year), even the large landowners would need 13 years to increase the size of large holdings by only a quarter. On the other hand, without technological progress the small and marginal landholdings would get smaller at a faster rate because of the distress sales of land by the poor.

Conclusions

The increase in agricultural income significantly expands the market for nonfarm goods and services, many of which are located in rural areas. The incremental budget share of these commodities is 52 percent for the technologically developed villages and 40 percent for the underdeveloped villages. The expansion of the market for cottage industry products and services, which are located mostly in rural areas, ia also proportionately greater than that of increases in income. Thus rural households may indirectly gain from employment generated in these activities. But the income growth does not promote capital accumulation in agriculture, presumably because the investment in irrigation, which is the main vehicle for technological progress, is made by the government. The opportunity for additional investment in nonagriculture is taken mainly by the higher-income groups in the technologically underdeveloped villages. Technological progress seems to follow more investment in the formation of human capital and more accumulation of land by large landowners in the developed villages. This suggests that unless the higher-income groups are induced to invest in production activities, or their surplus is siphoned off for acceleration of public investment, diffusion of the new technology may lead to further inequality in the distribution of landholding and agricultural incomes, both regionally and across income scales.

9

EFFECT ON INCOME DISTRIBUTION AND POVERTY

The impact of the differential rate of adoption of the new technology among farmers, the prices of products and inputs faced by them, and the effect of the technology on production, employment, and expansion of the market for nonfarm goods and services will ultimately bring about a change in the level and distribution of rural incomes. This chapter attempts to assess the impact from direct information on household incomes.

Since rural households do not keep records of their activities, it is difficult to estimate income accurately, particularly for activities conducted on a self-employed basis. Most rural households are also involved in many expenditure-saving activities such as producing fruits and vegetables in kitchen gardens, rearing poultry, fishing from nearby creeks and canals, processing food, and manufacturing personal and household effects, basically for family consumption. There is a tendency to underreport these activities, since the respondents do not generally consider them as sources of income.

In this survey, information has been collected as comprehensively as possible for estimating income. A detailed questionnaire on inputs and outputs for crop-production activities was administered three times during the survey year, at the end of each cropping season, to reduce errors attributable to faulty memory. Input-output information on processing, manufacturing, and trading activities was collected through quarterly surveys. The wage income and irregular expenditure-saving activities were recorded in a weekly consumption, expenditure, and employment survey that was administered eight times during the year. The annual incomes from these sources have been estimated by extrapolating from the estimates for the eight weeks.

Level and Structure of Income

The estimates of income obtained from the survey for households in technologically developed and underdeveloped villages can be reviewed in Table 64. For the entire sample, the average household income in 1982 is estimated at Tk 21,000 and per capita income at Tk 3,304. The latest national hosuehold expenditure survey conducted by the Bangladesh Bureau of Statistics estimates the per capita rural income for 1983/84 at Tk 3,883. At 1982 prices this yields Tk 3,347, which is very close to our estimate. The 1981/82 household expenditure survey, however, shows that the estimated rural per capita income was less than our estimate for 1982. This may be due to the selection of a larger proportion of the technologically developed area in our sample than in the country. In Bangladesh, 24 percent of the cropped area and 28 percent of the cereal area was under MVs during 1982/83. In our sample, the proportions were 37 and 46 percent, respectively.

The total household income was 29 percent higher in the technologically developed villages than in the underdeveloped villages, indicating a positive effect of the technology on the level of income. The number of persons per household is also higher in the developed area, so the difference in per capita income is less—about 22 percent. Compared with underdeveloped villages, the average size of the family in the developed villages was about 13 percent higher for the landless group but only 3 percent higher

Table 64—Structure of household incomes in technologically developed and underdeveloped villages, 1982

Sources of Income	Underdeveloped Villages: Annual Household Income	Underdeveloped Villages: Share of Source	Developed Villages: Annual Household Income	Developed Villages: Share of Source	Increase in Income in Developed Villages Over That in Underdeveloped Villages
	(Tk)	(percent)	(Tk)	(percent)	(percent)
Agriculture	11,178	61.0	15,644	66.2	40.0
Crop cultivation	6,258	34.1	9,265	39.2	48.1
Kitchen gardening	2,465	13.5	2,730	11.5	10.8
Livestock and poultry raising	1,272	6.9	1,511	6.4	18.8
Fishing	287	1.6	1,099	4.6	283.0
Agricultural wages	896	4.9	1,039	4.4	16.0
Nonagriculture	7,151	39.0	7,994	33.8	11.8
Cottage industry	726	4.0	268	1.1	–63.1
Trade	886	4.8	1,889	8.0	113.2
Services	3,268	17.8	4,417	18.7	35.2
Nonagricultural wages	2,271	12.4	1,420	6.0	–37.5
Total household income	18,329	100.0	23,638	100.0	29.0
Per capita income	2,961	. . .	3,626	. . .	22.4

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: The average household size was 6.52 in developed villages and 6.19 in underdeveloped villages, a difference of 5.3 percent.

for other groups. This may be the result of a reduction in mortality rates following the increases in income in very poor households.

As expected, the new technology has a more pronounced effect on agricultural incomes than on nonagricultural incomes. Nearly 61 percent of household income in underdeveloped villages originates from the agricultural sector, 52 percent from crop and vegetable production, and 9 percent from livestock and fishing. In developed villages, the crop sector income (including agricultural wages) was 44 percent higher, and total agricultural income was 40 percent higher than in underdeveloped villages. The increase in agricultural income was 48 percent for crop cultivation, and 16 percent for agricultural wages. The absolute level of nonagricultural income was also higher in the developed villages, but the difference is substantially less than for agricultural income. The income from trade and other services was about 52 percent higher in the developed villages, but the income from cottage industry and nonagricultural wages was lower by about 44 percent, which pushed down the income difference from nonagricultural sources between these two groups of households. Many cottage industries are low-productivity activities, and a part of the nonagricultural wages is earned from domestic service and earthwork—the jobs that are least preferred at higher levels of income. As argued in the chapter on employment, the stimulus from agricultural growth for these activities appears to be taken by households in underdeveloped villages and by lower-income groups.

Table 65 measures the income effect for different landownership groups by comparing the estimates for the developed and underdeveloped villages. It is found that among farming households the positive income difference for developed villages is higher for the large landowning groups—34 percent for the large landowner compared with 22 percent for the small and 28 percent for the medium owner, which suggests a trend

Table 65—Estimates of household income in developed and underdeveloped villages, 1982

Income/Landownership Group[a]	Underdeveloped Villages	Developed Villages	Difference in Developed Villages Over Underdeveloped Villages
	(Tk/household)		(percent)
Agricultural income			
Landless and marginal	3,708 (3,549)	8,000 (6,151)	116 (73)
Small	9,201	11,234	22
Medium	16,190	20,685	28
Large	29,437	39,435	34
Nonagricultural income			
Landless and marginal	6,036	6,264	4
Small	6,819	7,071	4
Medium	8,119	7,618	–6
Large	9,372	16,721	78
Total income			
Landless and marginal	9,743 (9,585)	14,264 (12,415)	46 (30)
Small	16,020	18,305	14
Medium	24,309	28,303	16
Large	38,809	56,156	45

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: Figures within parentheses are household incomes for the group, excluding the income from fishing. One of the villages under study has a high concentration of commercial fishermen, most of whom belong to the landless and marginal landowner group. This village is included in the developed area, so the high income of the landless from fishing in the developed villages may show a spuriously high positive impact of the new technology on the income for this group.

[a] Landless and marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

toward inequality in the distribution of income among farm households. But the group that has gained the most is the functionally landless, the bottom one-third of the rural households on the landownership scale. For this group, the income from agricultural sources is more than double in the developed villages over the underdeveloped villages. Further disaggregation of results for this group shows that a major source of the difference in income is due to fishing. Commercial fishing in Bangladesh is highly localized and in the sample it was concentrated in one village where land per person is extremely low, but where a large proportion of land is irrigated and cultivated with high-yielding varieties. The poor in this village earn a large proportion of their income from fishing, which cannot be attributed to the new technology. But even if fishing is excluded, agricultural income for the landless was 73 percent higher for the developed villages than for the underdeveloped villages—still higher than the income difference for the large landowning groups. The difference is mostly on account of income from cultivation (204 percent) and agricultural wages (79 percent). The transfer of irrigated land to marginal landowners through the tenancy market for cultivation of the rice MVs was an important mechanism for increasing the income of the poor from cultivation. In the underdeveloped villages a large proportion of marginal landowners rented out their tiny holdings and were dependent on the agricultural labor market and nonfarm activities for their livelihood. Only 32 percent of the sample households that own less than 0.5 acre of land received income from crop cultivation in underdeveloped villages, compared with 58 percent in developed villages. For the farm households in this group, the average income from crop cultivation was 65 percent higher in developed villages than in underdeveloped ones.

The figures in Table 65 show that the income gains from the nonagricultural sources have been confined mostly to the large landowning group. Compared with underdeveloped villages, the income from nonagricultural sources in developed villages is about 78 percent higher for the large landowner but 6 percent lower for the medium landowning group. Because of this unequal distribution of incremental income from nonagricultural sources, the difference in gains for the landless and large landowning groups narrows. For these groups the household income in the developed villages was about 45 percent higher—about three times the gains for the small and medium landowning groups.

The transfer of income to various landholding groups through the operation of the labor market can be assessed from wage earnings from agricultural and nonagricultural labor. The survey estimates of income from this source for the two groups of villages are reported in Table 66. The findings are similar to those reported in Chapter 7 about employment effects of the new technology. The agricultural wage income is inversely related to the size of landholding, and large landowners earn very little from this source. The agricultural wage income is about 16 percent higher in developed villages, but this is exclusively due to the functionally landless group, whose income from this source was about 79 percent higher in the developed villages. With increases in income the landowning group participates less in the agricultural labor market; their income from this source was substantially lower in the developed villages than in the underdeveloped ones. Only for the large landholding group was the wage income from nonagricultural labor higher in developed villages. The smaller landholding group had lower nonagricultural wage earnings in developed villages, indicating that with increases in agricultural income they withdraw some of the labor from the nonagricultural labor market. The income loss from this source was more pronounced for the small and medium landowners than for the landless.

Income Effect of Technology: A Regression Estimate

The previous section assessed the income effect of the modern technology by comparing the estimates of income for households in technologically developed and

Table 66—Incomes earned through the labor market, by technology and landholding groups, 1982

Landownership Group[a]	Agricultural Wage Income			Nonagricultural Wage and Salary Incomes		
	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference
	(Tk/household)		(percent)	(Tk/household)		(percent)
Landless and marginal	1,326	2,370	79	2,546	2,163	–15
Small	1,147	753	–34	2,850	1,364	–52
Medium	366	184	–50	1,835	761	–58
Large	31	94	[b]	349	1,000	187
All groups	897	1,039	16	2,271	1,420	–37

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless and marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

[b] Not estimated because of very small income from wage earning for this group.

underdeveloped areas. A limitation of this approach is that besides technology, a host of other factors determine income, and their effects cannot be dissociated when comparing mean values of the variables for the two groups. A more appropriate method of assessing the income effect of the new technology would be to fit a regression model, relating income to its determinants and incorporating technology as an additional explanatory variable.

The following regression model was fitted to explain household income:

$$\mathrm{INCM} = f(\mathrm{OWNL}, \mathrm{TNC}, \mathrm{CPTL}, \mathrm{WRKR}, \mathrm{EDCN}, \mathrm{DPND}, \mathrm{TECH}, \mathrm{OWNL}^2), \tag{20}$$

where

INCM = annual income of household (in taka),
OWNL = land owned by household (in acres),
TNC = land rented in by household (in acres),
CPTL = value of nonland fixed assets (in taka),
WRKR = number of family workers,
EDCN = educational level of head of household (completed years of schooling),
DPND = dependency ratio as measured by the number of consumers per worker in household,
TECH = technology at the household level as defined below.

The adoption of the technology at the household level, TECH, has been measured by three alternative specifications of the variable: the amount of land irrigated, LIRGN; the amount of land sown under rice MVs, LMV; and the expenditure on chemical fertilizers (in taka), FERT. Owing to the strong correlation among these three variables, each variable has been entered alternatively in the model to explain agricultural incomes.

The dependency ratio has been included to test the Chayanovian hypothesis that, in a peasant economy, the motive force behind the economic activity is the consumer-worker balance in the family.[111] This balance has already been found to be a significant variable affecting the labor supply of the household.

The square of owned land has been added to allow the marginal return from land to vary with the size of landownership. It has already been observed that crop yield varies inversely with farm size and that larger landowners prefer more leisure, which indicates that the marginal return from land will decline with the increase in the size of landownership.

The estimated values of the parameters of the income equation for total household income, as well as for agricultural and nonagricultural incomes, are reported in Table 67. The model explains about 55 percent of the variation in agricultural income and 52 percent of the variation in total income within the sample households. Land, both owned and rented, number of workers, and use of the new technology are found to be significant determinants of agricultural income. The value of nonland fixed assets

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[111] Chayanov, *Theory of Peasant Economy.*

Table 67—Determinants of rural household incomes: regression estimates, 1982

Variable	Agricultural Income			Nonagricultural Income	Total Income
	Equation (1)	Equation (2)	Equation (3)		
			(Tk)		
OWNL	. . .	3,244[a]	3,387[a]	3,486[a]	2,003,459[a]
	(14.24)	(14.87)	(14.63)	(1.08)	(11.26)
$(\text{OWNL})^2$	−63[a]	−43[a]	−41[a]	−2.5	−43[a]
	(7.54)	(5.28)	(−4.82)	(−0.36)	(−3.93)
TNC	1,067[a]	627[b]	708[c]	−183	351
	(3.27)	(1.90)	(2.08)	(−0.66)	(0.78)
CPTL[d]	0.021	−0.005	0.015	0.205[a]	0.101[a]
	(0.54)	(−0.13)	(0.35)	(6.04)	(2.66)
WRKR	1,313[a]	975[a]	1,075[a]	2,095[a]	3,125[a]
	(3.64)	(2.65)	(2.82)	(6.68)	(6.22)
EDCN	−123	−113	−129	249[a]	172[a]
	(−1.50)	(−1.37)	(−1.51)	(3.50)	(1.52)
DPND	636	799[b]	848[b]	827[c]	1,649[a]
	(1.41)	(1.75)	(1.79)	(2.13)	(2.65)
LIRGN	2,468[a]	. . .	. . .	. . .	. . .
	(7.87)				
LMV	. . .	1,729[a]	. . .	375[b]	1,973[a]
		(7.22)		(1.89)	(6.13)
FERT	. . .	. . .	. . .	2.17[a]	. . .
			(3.57)		
Constant	1,757	1,978	1,980	256	2,045
	(1.43)	(1.56)	(1.53)	(0.24)	(1.20)
$\bar{R}^2$	0.55	0.55	0.53	0.19	0.52

Note: Figures in parentheses are t-values.

[a] This number is significant at the 0.01 level.

[b] This number is significant at the 0.10 level.

[c] This number is significant at the 0.05 level.

[d] Capital is measured as agricultural capital for the agricultural income equation, nonagricultural capital for nonagricultural income, and total capital for total income equation. The sample size consists of 629 households with valid observations for all variables in the equation.

does not significantly contribute to agricultural income. The coefficient of this variable is not statistically significant in either of the agricultural-income equations. The values of the regression coefficient for agricultural income (Table 67, equation 1) indicate that an acre of owned land contributes at the margin Tk 3,200, while one family worker at the margin earns about Tk 1,300 a year. The marginal contribution of rented land is less than one-third that of owned land. This is understandable in view of the stringent conditions of the sharecropping arrangement—the tenant bears all costs of nonland inputs and pays half of the gross produce to the landowner.

The coefficient of all three technology variables in alternative equations for agricultural income is statistically significant at less than 1 percent probability of error. As discussed in Chapters 3 and 6, irrigation, MV seeds, and fertilizers are highly complementary, so the separate effect of each variable is difficult to measure. The value of the regression coefficient of each of the three technology variables thus measures the composite effect of all of them.

The marginal return from an acre of irrigated land is estimated at Tk 5,712 (3,244 + 2,468).[112] Thus, irrigated land and the associated increase in MV area and fertilizer use increase agricultural income at the margin by about 76 percent over that of nonirrigated land. The value of the coefficients of land variables (table equation 2) for agricultural income indicates that an acre of land under MVs increases agricultural income on the margin by about Tk 5,116—about 51 percent higher than the income earned at the margin from land devoted to traditional crop varieties (Tk 3,387). One taka of expenditure on fertilizer seems to increase agricultural income on the margin by Tk 2.17.[113]

The main determinants of nonagricultural income are the number of workers in the family, accumulation of nonagricultural assets, education, and the consumption pressure of the family. The regression coefficients of these variables are statistically significant at less than 5 percent probability of error. However, the explanatory power of the model is weak, as indicated by the low value of $\bar{R}^2$. This suggests that there may be other variables that determine nonagricultural income, or that the estimate of nonagricultural income at the household level involves a large margin of error, or both. Education increases household income mainly through involvement of the worker in the nonagricultural sector. The estimated value of the coefficient suggests that an additional year of schooling increases nonagricultural income on the margin by Tk 250 a year, but the increase is achieved partly at the expense of agricultural income, so its effect on total household income is less. The rate of return on accumulation of nonagricultural capital appears to be 21 percent. The households that cultivate more land with MVs have higher levels of nonagricultural income. This may be the effect of reallocation of family labor from agricultural to nonagricultural activities, which was explained in Chapter 7. The value of this coefficient is statistically significant at less than 10 percent probability of error.

In the estimated equation for total household income, the coefficient of the technology variable is found to be highly statistically significant. The values of the coefficient of the land variable (OWNL and LMV) show that a shift of land from traditional to modern varieties would increase the marginal return from land by about 57 percent. The coefficient of the square term of land is negative and highly statistically significant. It indicates that the marginal income from land declines with increases in the size of landownership. This may be the result of the negative income effect on the supply of labor, as reported in Chapter 7, which operates particularly in the agricultural sector. This finding also supports the hypothesis that when income increases, the forces in the labor market may operate to redistribute some income from upper- to lower-income groups.

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[112] The equation is fitted in the following form:

$$Y = a_0 + a_1 (x_1 + x_2) + a_2 x_2,$$

where x_1 is the amount of unirrigated land and x_2 is the amount of irrigated land. It can be rewritten in the following form:

$$Y = a_0 + a_1 x_1 + (a_1 + a_2) x_2.$$

Thus a_1 is the coefficient of unirrigated land and $(a_1 + a_2)$ is the coefficient of irrigated land.

[113] The estimate is close to the incremental-benefit cost ratio of fertilizer estimated by the IFDC from the crop-specific fertilizer response functions fitted on the farm survey data for 1979-82. The weighted average value for six rice varieties evaluated at 1984 prices of fertilizer and paddy is 2.5. See Hossain, "Fertilizer Consumption," p. 195.

Distribution of Income

The sample households have been ranked on the basis of per capita income, and the income shares of successive decile groups have been estimated in order to see the pattern of income distribution in the sample. The impact of technological progress on income distribution has been assessed by comparing the income shares of various groups in the technologically developed and underdeveloped villages. The results can be reviewed in Table 68 and also in Figure 5, which shows a Lorenz curve depicting the pattern of income distribution across the landownership scale.

The income distribution is fairly unequal. The bottom 40 percent of the households in the per capita income scale get about 21 percent of the total income, while about 24 percent of the income accrues to the top 10 percent of the households. The pattern of distribution of income in developed villages was found almost the same as that estimated for rural Bangladesh by the national household expenditure survey of 1981-82. The income, however, appears to be more unequally distributed in the technologically developed villages. The income share of the top 10 percent of the household is about 26 percent in the developed villages, compared with 21 percent in the underdeveloped villages. But the position of the bottom 40 percent of the households does not change. Their share of income is 21.2 percent in the developed villages compared with 21.1 percent in the underdeveloped villages. So the middle 40 percent in the income scale (third and fourth quintiles) are squeezed, and their income share declines from 42 to 39 percent.

The degree of inequality in income distribution is often summarized by the Gini concentration coefficient. The estimated values of the coefficients, based on individual household data, are presented in Table 69. The concentration ratio is estimated at 0.39 for household income, but since higher-income households typically have a larger number of persons, the degree of concentration in per capita income is less, at 0.35. Agricultural income is highly unequally distributed; the concentration ratio is estimated at 0.62. This is, however, related mostly to unequal distribution of landownership, since land is the most important asset determining agricultural income. The degree of inequality in the distribution of nonagricultural income is 0.44. Households that have

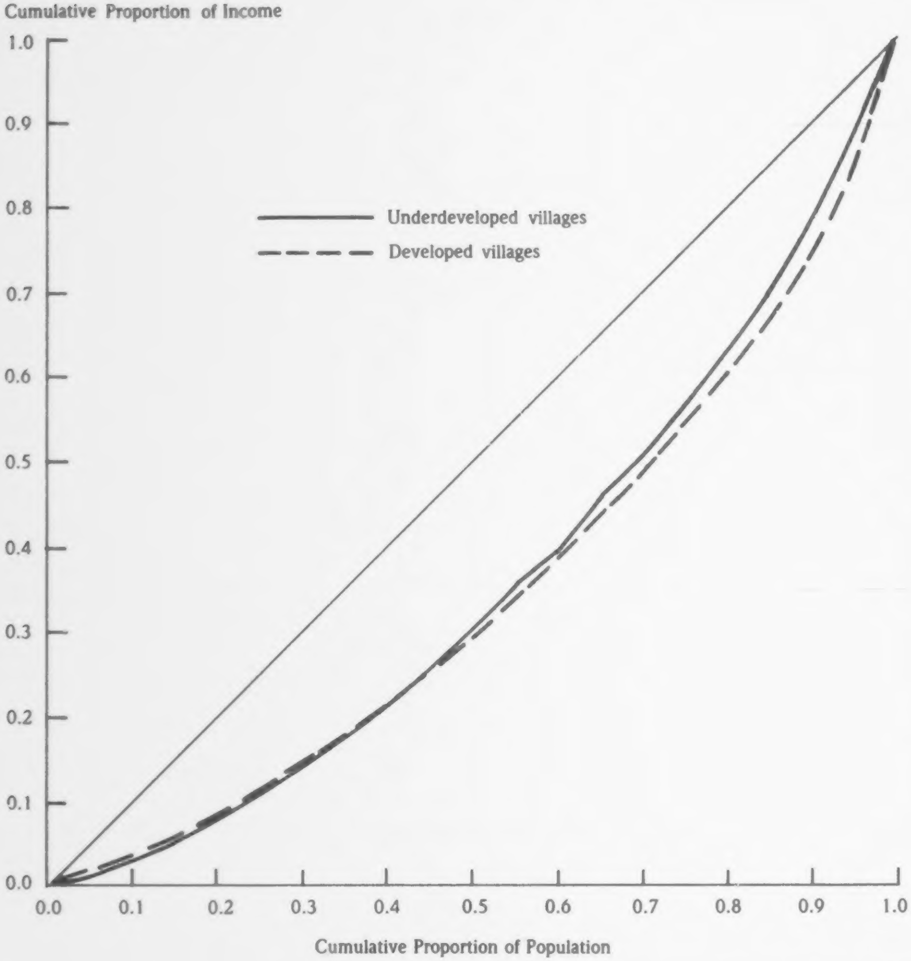
Table 68—Distribution of household income in technologically developed and underdeveloped villages, 1982

Household Ranking by per Capita Income	Income Share of Sample Households, 1982		
	Underdeveloped Villages	Developed Villages	Rural Bangladesh 1981/82[a]
		(percent)	
Bottom 20 percent	7.7	8.0	7.1
Second 20 percent	13.4	13.2	11.7
Third 20 percent	18.4	17.0	16.2
Fourth 20 percent	24.0	21.9	22.6
Top 20 percent	36.5	39.9	42.4
Top 10 percent	21.4	25.8	26.7
Top 5 percent	10.7	15.6	16.8

Source: The figures for rural Bangladesh are from Bangladesh, Bureau of Statistics, *Report of the Bangladesh Household Expenditure Survey, 1981-82* (Dhaka: Ministry of Planning, 1986).

[a] The households have been ranked by total household income.

Figure 5—Lorenz curve showing the pattern of distribution of income in developed and underdeveloped villages along per capita income scale, 1982



less access to land, and hence to agricultural income, tend to compensate by involving themselves more in nonagricultural activities; thus the concentration of household income is lower than that of either agricultural or nonagricultural income.

Technological progress seems to improve the distribution of agricultural income. The concentration ratio is estimated at 0.60 in developed villages, compared with 0.63 in underdeveloped villages, while the concentration in the distribution of landownership is similar. But the distribution of nonagricultural income becomes more skewed, leaving the distribution of total household income unchanged. With increases in income, the family size of the lower-income group increases proportionately more than that of higher-income groups, presumably due to declines in mortality rates, thus making the distribution of per capita income relatively more skewed in the developed villages.

Table 69—Degree of inequality in distribution of income and landholding: Gini ratios for sample households, 1982

Variable	Underdeveloped Villages	Developed Villages	Entire Sample
Land owned	0.61	0.60	0.61
Agricultural income	0.63	0.60	0.62
Nonagricultural income	0.43	0.45	0.44
Household income	0.39	0.38	0.39
Per capita income	0.34	0.36	0.35
Per capita income with adjusted household size[a]	0.33	0.34	0.34

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Adjusted to adult equivalent consumption unit from age-sex composition of household members.

Alleviation of Poverty

From the welfare point of view, the most appropriate indicator of the effectiveness of a development policy is its effect on the poor. So in recent years there has been a great deal of interest in measuring changes in the incidence of poverty and judging programs and policies on the basis of their effect on the alleviation of poverty.

A conventional way to measure poverty is to establish a poverty line, defined as the threshold level of income needed to satisfy basic minimum food and nonfood requirements, and count the number of people living below that line—the "head-count method" of measuring poverty. For Bangladesh a number of studies have used this method to measure the changes in poverty over time. The usual approach has been to take the normative requirement of different kinds of food (as recommended by the FAO) as the minimum consumption bundle, which gives a per capita intake of 2,100 kilocalories per day, and estimate its cost by applying retail prices for these items. Some adjustment is then made for the requirement of nonfood necessities. Separate poverty lines are estimated for rural and urban areas by taking into account urban-rural differences in price levels. Using this method, the poverty line for rural households was estimated by the author[114] at Tk 1,800 per person for 1978/79. After adjustment for changes in the cost-of-living index for rural areas, the poverty line for 1982 was estimated at Tk 2,392.

Recently the Bangladesh Bureau of Statistics has made alternative estimates of the poverty line for different levels of calorie consumption in the population on the basis of household-level data on income and calorie intake of the population obtained from the 1981/82 national household expenditure survey.[115] To avoid the problems of (1) identification of the minimum needs for different types of food in the consumption basket, and (2) choice of representative items for different consumers, the poverty line was estimated by fitting an equation of per capita income to per capita calorie intake and then determining the income for the threshold calorie intake. For rural households the method yielded a poverty line of Tk 2,304 for a daily intake of 2,200 kilocalories per person, and Tk 1,680 for an intake of 1,800 kilocalories per person for 1981/82. The first may be referred to as the threshold income for moderate poverty and the second for extreme poverty. After adjustment for changes in the rural cost of living, the lines are estimated for 1982 at Tk 2,374 and Tk 1,731 per person per year for moderate and extreme poverty, respectively.

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[114] Mahabub Hossain, Atiur Rahman, and M. M. Akash, *Agricultural Taxation in Bangladesh: Potential and Policies,* Research Report 42 (Dhaka: Bangladesh Institute of Development Studies, 1985).

[115] Bangladesh, Bureau of Statistics, *Bangladesh Household Expenditure Survey,* pp. 40-45.

It may be noted that the two methods described above yield almost the same poverty threshold income for an intake of around 2,200 kilocalories per person per day. Since the Bureau of Statistics estimate is based on a recent survey of a large number of households and is available for two alternative intakes of energy, the Bureau of Statistics norm has been applied to the income distribution data for this sample to estimate the proportion of population living below the poverty line.

The estimates are reported in Table 70. For the sample as a whole, 39 percent of the population were below the line of moderate poverty and 21 percent below the line of extreme poverty. The estimates are somewhat lower than those for rural Bangladesh derived from the 1983/84 household expenditure survey data, which show that 44 percent of the population had income below the moderate poverty line and 29 percent below the extreme poverty line. The national-level estimates are, however, comparable with the findings here for the underdeveloped villages.

Technological progress seems to have a significant impact on alleviation of rural poverty. The proportion of population below the moderate poverty line was 32 percent in the developed villages, compared with 47 percent in the underdeveloped villages, that is, about one-third of the poor has moved up the poverty line. The progress has been achieved mainly at the bottom of the income scale. The population under extreme poverty was only 15 percent in the developed villages, compared with 27 percent in the underdeveloped villages. For the landless group the proportion under moderate poverty was 63 percent for the entire sample; 51 percent in the developed villages, compared with 78 percent in the underdeveloped villages (Table 71). The proportion under extreme poverty for this group is down from 54 percent in the underdeveloped villages to 28 percent in the developed ones.

The head-count measure of poverty has the limitation of being insensitive to changes in the level and distribution of income among the poor. For a more significant assessment of the changes in poverty, two other indicators are suggested to supplement the head-count measure. These are the poverty-gap ratio, which measures the shortfall of the mean income of the poor from the poverty line, and the Gini concentration ratio of

Table 70—Estimates of incidence of poverty in technologically developed and underdeveloped villages, 1982

	Moderate Poverty			Extreme Poverty		
Indicator	Underdeveloped Villages	Developed Villages	All Villages	Underdeveloped Villages	Developed Villages	All Villages
Proportion of population in poverty	0.467	0.317	0.390	0.273	0.151	0.211
Poverty-gap ratio	0.329	0.264	0.303	0.262	0.216	0.246
Concentration of income among the poor (Gini ratio)	0.17	0.14	0.16	0.14	0.13	0.14
Sen's index of poverty	0.207	0.116	0.162	0.100	0.048	0.740

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Table 71—Incidence of poverty, by landownership group and technology, 1982

	Moderate Poverty			Extreme Poverty		
Land Owned	Underdeveloped Villages	Developed Villages	All Areas	Underdeveloped Villages	Developed Villages	All Areas
(acres)	(proportion of total population in the group)					
0.50 or less	0.783	0.510	0.634	0.537	0.279	0.396
0.51–2.00	0.509	0.363	0.438	0.534	0.189	0.255
2.01 or more	0.285	0.174	0.228	0.089	0.080	0.081

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

income for the poor. Sen has suggested a weighted index of poverty incorporating all three indicators. The Sen index is given by

$$P = H[I + (1 - I)G],$$

where P is the Sen index, H is the head-count ratio, I is the income-gap ratio, and G is the Gini coefficient of the income distribution of the poor.[116]

The estimates of the supplementary indicators of poverty and of the Sen index are reported in Table 70. The results are similar to that assessed by the head-count measure. The Sen index of poverty for developed villages is almost half of that in the underdeveloped villages, whether one takes the moderate or the extreme poverty line.

Conclusions

The potential for increasing rural incomes through diffusion of the modern technology is substantial. In technologically developed villages, where nearly three-fifths of the cropped land was under rice MVs, income was about 40 percent higher than in the villages where less than 10 percent of the area had been covered. Among farmers the income difference was found to be higher for large landowners, indicating a trend toward inequality, but for the landless the income difference was as high as for the large landowners. The top 20 percent in the per capita income scale have gained in relative terms, the bottom 40 percent have remained unaffected, while the middle 40 percent have been squeezed—although the absolute gain has been positive for all income groups. The Gini coefficient of concentration for household income was found to be the same (0.39) for both groups of villages, but the coefficient for per capita income was only marginally higher for developed villages.

Technological progress seems to have made a significant impact on alleviation of rural poverty. The proportion of people living below the poverty line, the poverty-gap ratio, and the concentration ratio of income of the poor are all lower in the technologically developed villages than in the underdeveloped villages. For the landless, the proportion of population living below the line of moderate poverty was estimated at 51 percent for the developed villages, compared with 78 percent for the underdeveloped villages. The Sen index of poverty was 0.116 for the developed villages—a substantial reduction when compared with the 0.207 estimated for the underdeveloped villages.

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[116] A. K. Sen, "Poverty: An Ordinal Approach to Measurement," *Econometrica* 44 (March 1976): 219-231.

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POLICY IMPLICATIONS

Technological progress is the key to overcoming the land constraint to growth of foodgrain production in Bangladesh. Indeed, the country has maintained the food-population balance in the postindependence period mainly through technological progress. Between 1970 and 1985 the area cropped with MVs increased by more than five times, from 1.2 to 6.9 million acres, and the consumption of chemical fertilizers increased from 0.15 million tons of nutrients to 0.59 million tons. Although the land under cultivation has remained stagnant at about 22.2 million acres, technological progress has made possible an acceleration of the rate of growth of crop production from 2.5 percent a year during 1950-71 to 2.9 percent during 1971-85, and of growth of cereal production from 2.6 to 3.4 percent during the same period. Technological progress has cut the unit cost of production of rice by about one-fifth and has increased gross profits per unit of land by 1.2 times. The analysis of detailed household data for 16 villages at different levels of technological development shows that all this may have been achieved with a somewhat neutral income distribution effect and a significant reduction in the incidence of rural poverty.

There is a vast potential for further diffusion of the new technology that will have to be exploited to feed the fast-growing population of the country. The following major policy directions are suggested by the study for realization of the potential.

Strengthening Agricultural Research and Extension

Credit for the diffusion of modern technology to present levels is mainly due to the Bangladesh Rice Research Institute (BRRI), which has done a commendable job of developing MVs that are suitable for local agroclimatic conditions and acceptable to consumer tastes. Support for the research effort is essential in order to continue the search for higher-yielding varieties that will increase production from the fixed amount of land and keep down the cost of production.

The new varieties have been adopted mainly for the dry season under irrigated conditions. In Bangladesh, however, rice is grown mainly under rain-fed conditions and the MVs have not found much acceptance for this production environment. More attention should be given to cropping system research on the possibility of adjustments in the existing cropping pattern that would encourage use of MVs in the monsoon season, and to development of higher-yielding varieties suitable for rain-fed conditions.

Diffusion of the modern technology is also constrained by other agroclimatic factors; for example, continuous deep flooding of a large proportion of land during the rainy season and high levels of soil salinity in the large coastal area. More attention should be given to investigating whether cost-effective, higher-yielding varieties could be developed for these unfavorable production environments.

The development of modern technology for rice and wheat has reduced the competitiveness of some noncereal crops, such as pulses and oilseeds, that are important as a source of protein for the poor. This study finds that in technologically developed villages only 10 percent of the cropped land is allocated to pulses, oilseeds, jute, and sugarcane, compared with about 26 percent in underdeveloped villages. Nationally, the sown area under noncereal crops declined from 22 percent during 1965-70 to 17 percent during

1980-85. Additional support is needed for research to develop suitable varieties for noncereal crops in order to make them competitive with rice and wheat MVs.

Farmers have experienced a faster increase in prices of modern agricultural inputs relative to output because initially these inputs were introduced at highly subsidized prices and the subsidies have been gradually phased out. There is still considerable subsidization of irrigation, and the reduction of subsidies may continue for some time. This phasing out has increased the unit cost of production and reduced the profits. These changes in relative input-output prices have affected the MVs most severely because they are heavy consumers of fertilizer and irrigation. The changes have also reduced the profitability gap between the traditional and modern varieties. It is estimated that between 1975/76 and 1984/85 the rate of profit over investment in working capital (cost of production) declined from 77 to 55 percent for the new varieties and from 49 to 43 percent for the traditional varieties (Chapter 4).

The adverse effect of the price trends on profits can be mitigated to some extent by increasing the efficiency of input use through more effective extension services. Bangladesh has long experience with agricultural extension and recently has reorganized it on the lines of a "Training and Visit" system, greatly increasing the number of extension agents at lower administrative tiers. The effectiveness of agricultural extension, however, remains a controversial issue. The gap in the yield of MVs and the response to chemical fertilizers achieved on government experimental farms is large compared with the results realized by farmers. Results of Bangladesh Rice Research Institute experiments reported by Zaman show that with 32 kilograms of nitrogen per acre, the yield for MVs increased to 2.45 tons for the boro season and 1.80 tons for the aman season.[117] With similar levels of fertilizer application during 1980-82, farmers actually produced 1.51 and 1.11 tons, respectively, during the boro and aman seasons. The response to fertilizer at farmers' fields is estimated at 4.3 units of paddy per unit of nutrient, compared with a 10:1 ratio under experimental conditions.[118] The gap cannot be completely eliminated, since most experiments do not represent farmers' conditions, but more effective extension services can reduce the gap and increase the profitability of cultivation.

Public Investment for Irrigation

The main vehicle for diffusion of the new technology has been development of irrigation facilities. It is the single most important determinant of adoption of the new technology. About 96 percent of the plots growing the new crops are irrigated, and the villages where the new technology has not yet developed are those that do not have access to irrigation facilities. In Bangladesh, however, irrigation facilities have been developed mainly by the government and mostly with foreign aid. Only about a fifth of the land has so far been brought under modern irrigation, although it is estimated that about three-fifths of the land could be irrigated with available ground- and surface-water resources.[119] The small size of farms, fragmented and scattered plots, and the indivisible nature of investment for irrigation development suggest that the private sector cannot be relied upon for investment in this field. The government has to take the leading role, as it has done in the past. During 1975-85 the government spent over 40 percent of the total development budget for the agricultural sector on water resource development, and the area irrigated by modern methods increased from 7 percent of cultivated land in 1974/75 to 21 percent in 1984/85. To maintain a moderate growth in cereal production and agricultural incomes, the government will have to maintain or even accelerate the allocation of public resources for investment in irrigation.

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[117] S. M. H. Zaman, "Agronomic and Environmental Constraints on Fertilizer Effectiveness," in *Fertilizer Pricing Policy in Bangladesh*, ed. Bruce Stone (Washington, D.C.: International Food Policy Research Institute/Bangladesh Institute of Development Studies, 1987), p. 248.

[118] Hossain, "Fertilizer Consumption," pp. 183, 195.

[119] Bangladesh, Master Plan Organization, *National Water Plan, Summary Report* (Dhaka: Ministry of Irrigation and Flood Control, 1986), pp. 62-64.

The capacity of the government to accelerate investment in irrigation and to support agricultural research and extension will depend on the availability of finance. So far, the government has been largely dependent on external resources (foreign aid and loans) for financing such investment. The present low level of foodgrain prices in international markets and the political pressure from food-exporting developed countries suggest that it will be increasingly difficult to mobilize foreign aid for projects that increase foodgrain production. Uncertainty about the future availability of foreign aid and the increased cost of debt servicing suggest that it is advisable for the government to seek out internal resources.

In the past, the government has had limited success in mobilizing resources from the agricultural sector.[120] Direct agricultural taxes, collected mostly through land revenue, have lost considerable ground as a major source of government revenue since the early 1960s—the real value of tax receipts during 1979-82 was only about 30 percent of the level reached during 1958-61. In recent years, direct tax has tapped about 2.25 percent of nonagricultural incomes, whereas agriculture's terms of trade during 1975-85 did not show any consistent downward trend, and the recent level of domestic rice and wheat prices is considerably higher than the prices prevailing in international markets, indicating that producers are protected at the expense of consumers.

The government should take steps to mobilize additional resources from the agricultural sector. A move in that direction could be made by recovering the cost of public investment from the beneficiaries. Subsidies for fertilizer have been withdrawn, but the subsidy for irrigation is still large. Shallow tubewells are sold to farmers almost at a cost price, but in 1982/83 there was about a 73 percent subsidy on deep tubewells and 29 percent on low-lift pumps.[121] For large-scale irrigation projects implemented by the Water Development Board, both the capital and the current costs are borne almost entirely by the government. The benefits of the subsidy are reaped mostly by the owners of the irrigation equipment, who are large and medium landowners. The small farmers who buy water from the owners of the machines are charged almost the market clearing rates. Indeed, this study finds that the difference in the price of water is a major source of inequality in the distribution of income from the new technology (Chapter 6). The irrigation charge is one-fourth higher for the small farmers than for the large ones. Thus it may be advisable to withdraw the subsidy on sale of irrigation equipment, and also to reduce the budget share of large-scale irrigation projects for water resource development, since the cost recovery of large-scale projects has proved to be extremely difficult. The initial reaction of farmers to withdrawal of the subsidy may be adverse, which may temporarily slow the technological diffusion, but the adverse reaction should not last long. The difference in profits between cultivation of modern (irrigated) and traditional (unirrigated) varieties is about Tk 1,250 per acre at 1984/85 prices, and the withdrawal of irrigation subsidies would not eliminate this gap (Chapter 4). On the other hand, it would reduce the income disparities due to differential irrigation charges between farmers growing traditional and modern varieties, between technologically developed and underdeveloped regions, and between farmers with access to different irrigation projects and equipment.

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[120] Hossain, Rahman, and Akash, *Agricultural Taxation in Bangladesh,* pp. 10-27.

[121] Osmani and Quasem, "Pricing and Subsidy Policies," p. 205.

Provision of Credit

The amount of loans obtained from both institutional and noninstitutional sources is found to be a significant determinant of adoption of the new technology (Chapter 6). This is understandable, since the working capital needs on account of purchased inputs—fertilizer, irrigation, and even hired labor—are much higher for the MVs than for the local varieties, for which most of the inputs are supplied from within the household. The cash cost of production at 1984/85 prices is estimated at Tk 2,120 per acre for MVs compared with Tk 800 for traditional varieties—an increase of about 165 percent. It is difficult for the small farmer to manage such a large investment from accumulated savings.

The government of Bangladesh recognizes the credit needs of the farmers. From 1975 to 1984, institutions that provide agricultural credit proliferated, and the number of bank branches operating in rural areas increased from 854 in 1975/76 to more than 3,200 in 1983/84. The supply of institutional credit at real value increased about eight times over this period. Credit disbursed during 1983/84 amounted to 7 percent of the value added in the agricultural sector—about 40 percent of the cost of material inputs and 2.3 times the cost of chemical fertilizers consumed in the country.[122] But owing to the weakness of the credit institutions, credit has remained concentrated in the hands of the medium and large farmers, and complicated loan-sanctioning procedures have led to untimely disbursement, which together with the spread of corruption among bank officials has promoted laxity in credit disciplines and poor recovery. The small farmers who need credit badly have suffered. They have to rely on noninstitutional markets where the cost of a loan is substantially higher, and to that extent they benefit less from utilization of the loan, compared with the medium and large farmers who have access to low-interest loans from institutional sources. Obviously, there is a need for overhauling the institutions and management of agricultural credit so that credit can be better targeted to smaller farmers. The government may consider elimination of subsidies on agricultural credit and a policy of variable cost of loan funds to banks, depending on the proportion of loans given to small and marginal farmers.

The findings of this study also point to the need for providing working capital loans to the poor so that they can generate more employment in the rural nonfarm sector. The increase in agricultural income from technological progress has a significant impact on the expansion of the market for nonfarm goods and services, which generates more employment opportunities in the nonfarm sector. But some working capital is needed for self-employment in these activities. The duration of self-employment in general, and in nonagriculture in particular, is found to be significantly related to the amount of nonland capital owned by the household (Chapter 7). Owing to the lack of capital, the poor cannot take full advantage of employment opportunities generated in nonfarm activities. The findings show that the additional employment in nonagriculture is taken up by the large landowning groups rather than by the landless (Chapter 7), and that the incremental income from nonagriculture is distributed in favor of the higher income groups (Chapter 9).

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[122] Hossain, "Institutional Credit for Rural Development," pp. 3-5.

Experiments conducted by the Grameen Bank show that if credit is provided to the poor, they can generate productive self-employment in the nonfarm sector and significantly improve their standard of living.[123] The Grameen Bank provides loans to the landless without any collateral and recovers about 98 percent of the loans on time. The borrowers utilize the loans in family-based enterprises for livestock raising, cottage industries, and trade and shopkeeping, generating employment mostly for women. Since technological progress stimulates demand for these activities, the expansion of working capital loans for the poor in technologically developed areas should be considered to help generate more employment for the poor and improve income distribution.

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[123] Hossain, "Credit for Alleviation of Rural Poverty."

APPENDIX:

SUPPLEMENTARY TABLES

Table 72—Estimates of growth equations for crop production, 1950-85

Crops/ Dependent Variable	Regression Coefficients				$\bar{R}^2$	'F' Statistic
	Constant Term	Time (T-1949)	Dummy (1 for 1971-85)	Time × Dummy		
Cereals						
Area	8.973	0.0110 (8.52)	−0.0525 (−0.75)	0.0006 (0.22)	0.88	85.4
Yield	8.340	0.0152 (8.10)	−0.2519 (−2.46)	0.0068 (1.73)	0.87	80.0
Production	10.405	0.0262 (10.09)	−0.304 (−2.16)	0.0074 (1.36)	0.91	122.0
Noncereals						
Area	7.289	0.0127 (3.78)	0.335 (1.83)	−0.0200 (−2.84)	0.27	5.3
Yield	8.639	0.0089 (4.78)	−0.1470 (−1.46)	0.0038 (0.97)	0.69	26.4
Production	9.021	0.0215 (6.45)	0.1878 (1.03)	−0.0162 (−2.31)	0.59	17.6
All crops						
Area	9.145	0.0112 (8.59)	−0.0008 (−0.01)	−0.0022 (−0.82)	0.85	66.0
Yield	8.486	0.0140 (9.38)	−0.233 (−2.86)	−0.0062 (1.96)	0.90	104.5
Production	10.631	0.0252 (11.60)	−0.234 (−1.98)	0.0039 (0.86)	0.92	140.7

Source: Estimated from official statistics from Bureau of Statistics, Bangladesh.
Notes: Dependent variables are measured in logarithms. Figures in parentheses are estimated t-values.

Table 73—Marginal budget shares and expenditure elasticity of demand for different commodities, 1982

Commodity Group	Underdeveloped Villages			Developed Villages		
	Average Share	Marginal Share	Expenditure Elasticity	Average Share	Marginal Share	Expenditure Elasticity
		(percent)			(percent)	
Crops	66.97	56.47	0.84	62.91	44.95	0.71
Rice	44.55	42.33	0.95	43.78	32.81	0.75
Wheat	8.42	−0.27	−0.03	5.33	−1.57	−0.29
Pulses	1.07	1.32	1.24	0.75	1.16	1.56
Roots	1.75	1.33	0.76	1.55	1.19	0.77
Vegetables	3.68	3.39	0.92	3.27	1.95	0.60
Spices	3.44	2.88	0.84	3.66	3.33	0.91
Betel nuts and betel leaves	0.91	1.42	1.55	1.34	1.34	1.00
Rice husks	0.53	0.35	0.65	0.21	0.24	1.16
Jute sticks	0.51	0.30	0.59	1.11	1.47	1.33
Fruits	2.12	3.42	1.62	1.92	3.02	1.57
Forestry	4.12	3.21	0.78	3.08	2.72	0.88
Firewood	2.02	2.59	1.29	1.53	2.06	1.35
Leaves	2.10	0.62	0.30	1.55	0.66	0.43
Livestock	4.43	5.70	1.29	4.00	6.35	1.59
Meat	1.12	2.47	2.20	1.74	3.80	2.18
Milk	0.94	1.82	1.93	1.25	2.41	1.92
Eggs	0.44	0.77	1.75	0.32	0.55	1.70
Cow dung	1.93	0.64	0.33	0.69	−0.41	−0.58
Fishery	3.55	4.22	1.19	4.35	5.32	1.22
Rural manufacturing	9.54	12.40	1.30	9.48	10.29	1.09
Gur (raw sugar)	1.59	2.20	1.39	1.50	2.11	1.41
Bidi (cigarettes)	1.48	0.72	0.48	1.37	0.79	0.57
Tobacco	0.17	0.25	1.42	0.17	−0.08	−0.44
Mustard oil	2.13	2.31	1.09	2.31	2.39	1.04
Sweets	0.06	0.15	2.44	0.06	0.14	2.48
Handloom clothing	3.77	5.98	1.58	3.70	4.22	1.14
Tailoring	0.35	0.79	2.29	0.38	0.73	1.94
Urban manufacturing	7.20	10.50	1.46	7.97	12.44	1.56
Mill-made clothing	0.52	1.38	2.63	0.97	1.89	1.94
Imported clothing	0.81	2.57	3.19	0.48	1.28	2.69
Old garments	0.29	0.20	0.66	0.28	0.15	0.53
Ready-made garments	0.42	0.79	1.86	0.51	0.87	1.73
Shoes	0.24	0.46	1.96	0.33	0.63	1.95
Sugar	0.28	0.30	1.08	0.35	0.88	2.50
Tea	0.06	0.06	1.00	0.35	0.70	2.01
Cigarettes	0.13	0.34	2.60	0.35	0.90	2.58
Soybean oil	0.34	0.19	0.57	0.13	0.25	1.90
Coconut oil	0.40	0.36	0.90	0.36	0.35	0.98
Kerosene oil	1.86	1.75	0.94	1.90	1.67	0.88
Electricity	. . .	. . .	. . .	0.07	0.22	2.98
Matches	0.40	0.12	0.30	0.40	0.21	0.51
Soap	0.94	1.35	1.44	1.01	1.61	1.59
Washing soda	0.25	0.15	0.62	0.10	0.05	0.47
Toiletry and cosmetics	0.07	0.18	2.50	0.17	0.33	2.00
Other	0.19	0.30	1.58	0.21	0.45	2.14
Services	4.20	7.50	1.79	8.21	17.93	2.18
Education	0.63	1.72	2.74	1.00	2.58	2.57
Health	1.36	1.90	1.39	2.49	4.58	1.84
Transport	0.73	0.95	1.30	0.98	1.93	1.96
Personal services	0.35	0.39	1.11	0.50	0.53	1.06
Religious services	0.60	1.25	2.10	2.38	5.48	2.30
Other services	0.53	1.30	2.44	0.86	2.83	3.28

Source: Estimated by fitting Engel functions to data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

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